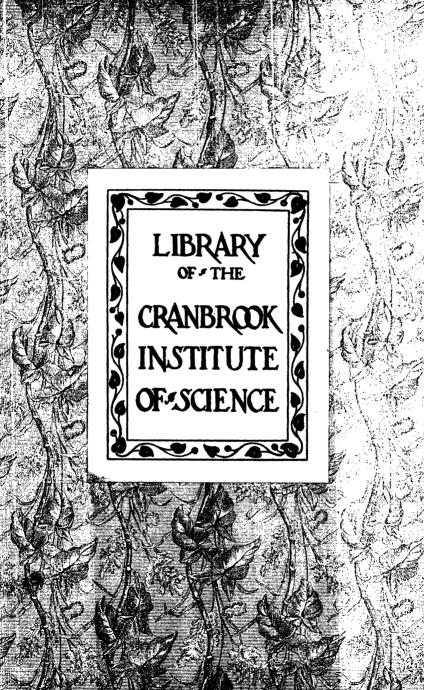
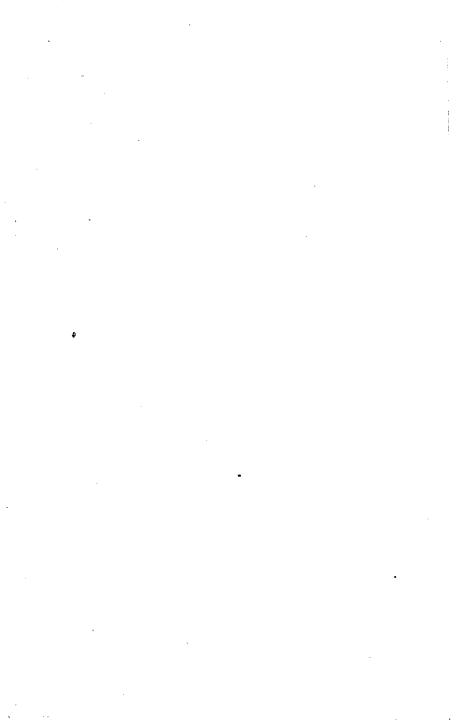
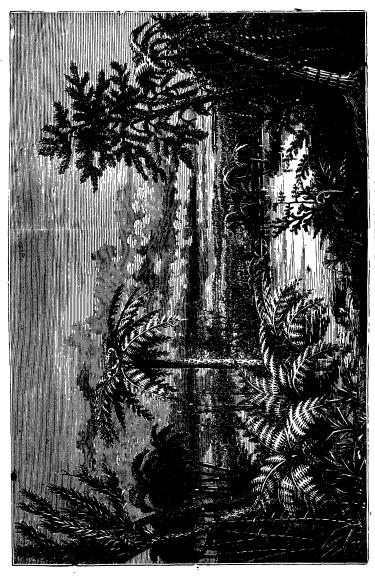
OUR MATIVE FERNS AND THEIR ALLIES UNDERWOOD











OUR

NATIVE FERNS

AND

THEIR ALLIES

WITH

Synoptical Descriptions of the American Pteridophyta North of Mexico

A SECOND AND ENLARGED EDITION OF OUR NATIVE FERNS AND HOW TO STUDY THEM

LUCIEN M. UNDERWOOD, PH. D.
PROFESSOR OF GEOLOGY AND BOTANY IN THE ILLINOIS WESLEYAN UNIVERSITY

He prayeth best who loveth best All things, both great and small; For the dear God who loveth us, He made and loveth all.

COLERIDGE.

ILLUSTRATED

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LUCIEN M. UNDERWOOD

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→ PREFACE►

The success of Our Native Ferns and How to Study Them resulting in the disposal of the entire edition within a twelvementh after publication may be a sufficient apology for the present volume.

Much of the matter on Ferns has been introduced from the first edition unchanged, yet where a change seemed necessary or appropriate no pains have been spared in introducing it.

The more important addition is made in extending the work so as to include the "Fern Allies," that the work may serve as a manual for the entire group of Vascular Cryptogams or Pteridophyta. The chapter on "Fern Literature" has also been extended and while necessarily incomplete in even American authors it is hoped that it may form a nucleus for a complete bibliography of the subject.

In the preparation of chapters IV, V and VI, Sach's Lehrbuch has been freely consulted. The specific descriptions have been collected from various sources. Hooker's Synopsis Filicum and the papers by Prof. Eaton in Gray's Manual, Chapman's Flora, and "The Ferns of the Southwest," have furnished much of the material for the Ferns. Spring's Monographie de la Famille des Lycopodiacees, Milde's Monographia Equisetorum, and Dr. Engelmann's Isoetes in North America have served as the basis for the classification of the Fern Allies. In the last named genus the classification of Dr. Engelmann has been used without modification and his descriptions of our native species have suffered only verbal changes to correspond with the remainder of the work. The writer must here record his gratitude to Dr. E. for his kindly

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assistances in this genus as well as *Marsilia*, and must also include Mr. George E. Davenport for many favors connected with the preparation of this volume. It was through his kindness that specimens of *Polypodium Swartzii* were received just in time to insert its specific description in the proper place. In short every available aid has been utilized in making the work in every way a satisfactory manual of the ferns and their allies.

No attempt has been made to popularize the language of the work at the expense of scientific accuracy, the writer fully believing that if this subject or any other department of natural science is ever studied with any satisfaction to the learner, it must be accomplished by severe and unflinching mental effort. It is hoped, however, that the language is sufficiently clear to be readily appreciated by those who are really interested in the subject.

The illustrations are largely from drawings by the writer. Some have been copied from other authors, as is in each case acknowledged. The valuable frontispiece was secured through the kindness of Dr. James D. Dana.

In conclusion the writer would acknowledge with gratitude the kindnesses shown him by many friends in the preparation of this volume. Though not mentioned by name, their kindness is none the less appreciated.

L. M. U.

Bloomington, Ill., May, 1882.

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→ ABBREVIATIONS ►

	M. Adanson.
Атт	W. Aiton.
Angs	Angstræm.
Beauv	' P. de Beauvais.
Bernh	J. J. Bernhardi.
Bigel	J. Bigelow.
Вкаск	W. D. Brackenridge.
A. Br	A. Braun.
R. Br	R. Brown.
Bong	Bongard.
Brong	A. Brongniart.
	A. J. Cavanilles.
Снарм	A. W. Chapman.
Dav	G. E. Davenport.
DC	A P. DeCandolle.
D. C. E	D. C. Eaton.
Desf	R. L. Desfontaines.
	N. A. Desvaux.
Енвн	F. Ehrhart.
	S. L. Endlicher.
	G. Engelmann.
	Hooker and Arnott.
	Hooker and Greville.
	Bonpland and Kunth.
	E. Hitchcock.
	G. F. Hoffman.
	.Baron von Humboldt.
	G. F. Kaulfuss.
	W. D. Koch.
	Kuhlewein.
	von Linne [Linnæus].
	J. B. de Lamarck.
L'HER	C. L. L'Heritier.

LIEBM	Liebmann.
LINDL	J. Lindley.
LINN. F	C. Linnæus (son).
MART. & GALE	Martens and Galeotti.
Метн	G. Mettenius.
Міснх	A. Michaux.
Muhl	G. H. E. Muhlenberg.
Neck	N. J. Necker.
Nutr	T. Nuttall.
Plum	C. Plumier.
REICHENB	H. G. L. Reichenbach.
Ricн	C. L. M. Richard.
	Schleicher.
Schreb	J. C. D. Schreber.
Sм	J. E. Smith.
J. Sm	J. Smith.
	K. Sprengel.
Swz	0. Swartz.
THUNB	C. P. Thunberg.
Torr	J. Torrey.
	E. Tuckerman.
VAILL	S. Vaillant.
	E. P. Ventenat.
WALL	N. Wallich.
WALLR	F. W. Wallroth.
WALT	T. Walter.
W1LLD	K. L. Willdenow.
	
	Greek.
	Latin.
	millimetre.
	variety.
	feet.
<i>'</i>	inches.

- INTRODUCTION ▶

In the entire vegetable world there are probably no forms of growth that attract more general notice than the Ferns. Delicate in foliage, they are sought for cultivation in conservatories and Wardian-cases, and when dried and pressed add to the culture of many a domestic circle by serving as household decorations. They furnish to botanists a broad and inviting field for investigation, and he who examines their more minute structure with the microscope will find deeper and still more mysterious relations than those revealed to the unaided eye. Ferns thus appeal to the scientific element of man's nature as well as to the æsthetic, and while they highly gratify the taste, they furnish food for the intellect in a like degree.

The Fern-allies have also played their appointed part in the domestic and decorative economy of this and other generations. The scouring-rushes served our ancestors for keeping white their floors and wooden-ware in the days when carpets were a luxury. The trailing stems of various species of Lycopodium have long been valued for holiday decorations; while their burning spores have flashed in triumphal processions, and have added their glow to the fervor of political campaigns.

In olden time the obscure fructification of the common brake led to many superstitious ideas among the common people and the older poets have woven these popular notions into our literature. Butler tells in Hudibras of bugbears so often created by mankind:

"That spring like fern, that infant weed, Equivocally without seed, And have no possible foundation But merely in th' imagination."

Shakespeare only reflects a prevalent belief of his time when he says:

"We have the receipt of fern seed; we walk invisible."

Others allude to the falling of the seed on the anniversary night of the birth of the 'loved disciple.' The old simplers with their lively imagination were impressed by the fancied resemblances of some parts of fern growth to various organs of the human body, and introduced them into their system of specifics. Traces of their influence still remain in the names of some of our common ferns as spleenwort and maidenhair.

To form a correct understanding of ferns we must study the ferns themselves as well as the text-book, as it is only by direct contact with nature that we gain definite and satisfactory information. The text-book is only useful in giving directions how to investigate. To understand thoroughly an animal we must study its habits in its native haunts. To know its structure and position in the animal kingdom we must carefully dissect a large number of specimens and study the development of the individual from its beginning. In like manner, to understand fully a fern we must search were nature has planted it, watch it as it uncoils from the bud, matures, produces its fruit, and finally returns to the earth: examine it with needles and lenses and discover its minute structure and its life-history. These pages which aim to give an outline of the forms of fern growth, the methods of fruiting, the germination or growth from the spore, and finally the more minute structure of the entire plant, can only be thoroughly understood by taking the ferns in hand and studying them in connection with the text. For the first three chapters and the determination of species a strong pocket lens and a few needles mounted in handles for dissection will furnish the necessary outfit. Chapters IV. and V. will require a compound microscope with its appliances for successful investigation.

Let no one imagine that the task will be an easy one. Patient application and careful observation are essential to success, yet he who becomes once interested in the work will find a subject that deepens in interest with every step and even becomes enchanting as he seeks to determine the mysterious processes of fern development and the marvels of fern structure.



OUR NATIVE FERNS AND THEIR ALLIES

CHAPTER I

HAUNTS, HABITS, AND DISTRIBUTION OF FERNS

Our outward life requires them not,—
Then wherefore had they birth?
To minister delight to man,
To beautify the earth.

-MARY HOWITT.

r. General Characters.—Our native ferns comprise plants varying in height from less than an inch to six or seven feet, or even more. Some are stout and fleshy, others are delicate and even filmy, but most are herbaceous, resembling ordinary flowering plants in the texture of their foliage. While most would be recognized as ferns by even a novice, a few differ so widely from the ordinary typical forms that to an unskilled observer they would scarcely be considered as bearing any resemblance to ferns whatever. The fronds of one of our Florida species resemble narrow blades of grass, and the fertile spikes of another from New Jersey might be mistaken for a diminutive species of sedge. A third from Alabama would, perhaps, be called a moss by the inexperienced, while the "Hartford fern" found from New England to Kentucky has a climbing stem and broad palmate leaves.

When we add to these peculiar forms of our own country those of foreign lands, and include the immense tree-ferns of tropical regions, we find our early conception of a fern inadequate to cover this diversity of forms. Without attempting an accurate definition of a fern, let it be regarded for present purposes as a flowerless plant, producing spores instead of seeds, possessing more or less woody tissue, and having its leaves coiled in the bud from apex to base. After the necessary study of the structure of some of our common ferns, we will be able to comprehend the more technical definition found later in the work.

- 2. Mode of Growth.—Ferns vary greatly in their method of growth, yet each species has a plan which, within certain limits, is fixed and definite. Some, like the common brake, have their fronds rising from more or less distant portions of the creeping rootstock. Others are tufted, many fronds rising irregularly in a cluster, while still others grow in crowns or circles, the later fronds continually rising within the older ones. In the grape-ferns (Botrychium) the rootstocks usually produce a single frond each season, the bud for the succeeding year growing within the base of the common stalk.
- 3. In many there is a tendency to dimorphism, the fertile or fruit-bearing fronds differing to a greater or less extent from the sterile ones. In a few species, like the sensitive-fern and the ostrich-fern (Onoclea), this is carried so far that the sterile and fertile fronds bear no resemblance to each other, and in one instance have been mistaken for different species and so described.
- 4. Variation.—The same species will often present wide differences in the size of the fronds. This depends to some extent on the character of the soil and the ordinary climatic conditions. For example, the lady-fern (Asplenium filix-fæmina), which in ordinary locations grows from two to four feet high, in mountainous regions is sometimes reduced to from three to six inches, when it forms the var. exile. In like manner the marginal shield-fern (Aspidium marginale) usually two or three feet high, is reduced to five inches when growing on rocky cliffs, and yet regularly produces fruit.*
- 5. In some cases there is a tendency to variation in size that cannot be referred to soil or climatic influences. The common grape-fern (Botrychium Virginianum) will be found in some localities to vary from six inches to two feet in height, all well fruited and matured, and with the extreme sizes growing within a pace of each other in the same soil and with the same environment. The other species of the same genus present similar variations, and judging from size and external appearance alone, a regular gradation of forms might be arranged from the most diminutive undivided forms of B. simplex to the largest of B. Virginianum.
- **6.** Another tendency to variation is noticed in the forking of fronds either at the summit or at the ends of the branches. The hart's-tongue (*Scolopendrium*) is frequently forked at the summit,

^{*} Compare Bulletin Torrey Botanical Club, October, 1878.

the walking-leaf (Camptosorus) less commonly, while the same tendency is noticed in various compound forms, as Asplenium angustifolium, Cheilanthes vestita, C. Eatoni, Gymnogramme hispida, Dicksonia, Pellæa atropurpurea and others. Some of the species of Botrychium show the same tendency, especially in their fertile segments. It is probable that all our species will be found to fork under certain conditions.*

- 7. In those species whose sterile and fertile fronds are unlike, forms often appear that are intermediate between the sterile and fertile fronds and sometimes even form a graded series from one to the other. This is especially true of the sensitive-fern (Onoclea) and the cinnamon-fern (Osmunda cinnamomea) and has frequently been the source of so-called "varieties." Whether this variation arises from some peculiarity of environment, or from some inherent tendency to reversion toward an older form, will require more extended observation to determine.†
- 8. In a few forms there is an apparent mimicry, one species imitating another in foliage or method of fruiting. In the cinnamon-fern just alluded to, which has a cinnamon colored sterile frond totally unlike the fertile, sterile fronds will sometimes be found which are fertile at the apex, the normal method of fruiting in the royal flowering-fern (Osmunda regalis); and in turn the royal flowering-fern is sometimes fertile in the middle in imitation of Osmunda Claytoniana.
- 9. Time of Fruiting.—The time of maturing fruit is different among different species, and also varies with geographical location and proximity to tropical climates. In the Northern States some species produce their fruit as early as May (Osmunda cinnamomea), and others as late as September (Lygodium), but the greater number are best studied in July and August. In semitropical climates, like Southern California and the Gulf States, the time of fruiting is often earlier, sometimes occurring in February or March. Some fronds are killed by the early frosts, while others like the Christmas-fern, are evergeen and may be gathered in midwinter.
- 10. Local Distribution.—Ferns are largely dependent for successful growth on the amount of warmth, moisture and shade to which they are subjected, and we would naturally expect to find

^{*} See also Bulletin Torrey Botanical Club, August, 1880.

[†] The reader will find papers on this subject in the Torrey Bulletin for Sept. and Oct. 1881, and Jan. 1882. Further observations are desirable from other localities where these variations occur.

them reaching a maximum in size and abundance in warm swamps or shady marshes. While this is in general true, we nevertheless find many species thriving only in rocky places, thrusting their roots into the crevices of the rocks with little earth for their nourishment, and many times exposed to the scorching rays of the sun. Of necessity, such species are of comparatively small size, and likely to be protected in some way against the heat of the sun and the lack of moisture in times of drought. Others still are found in wet, rocky ravines, often where moistened by the spray of cascades or waterfalls, and, consequently, have no such provision against the heat of an extended summer. Certain others thrive in open fields that are comparatively dry and unshaded. One species of Southern Florida is aquatic, having the sterile fronds floating in shallow water. A few species are epiphytic, or grow on other plants, some being found on tree-trunks to the height of 150 or 200 feet!

So, while moisture, warmth and shade in abundance are the climatic conditions essential to promote luxuriant fern growth, it can and does continue when any or all these conditions are reduced to a minimum.

- 11. Ferns may then be sought in any of the following situations, and it will be seen that each situation has its characteristic species.
 - A. Wet swamps or marshes with or without abundant shade.
 - B. Rich woods, more or less moist.
 - C. Uncultivated open places and dry hillsides.
- D. Moist, rocky ravines or rocky places not subject to summer drought.
 - E. Exposed rocky cliffs.
 - F. Standing water.
 - G. Growing on other plants. (Epiphytic.)
- 12. In the first location mentioned above, we may find the chain-ferns (*Woodwardia*), many of the spleenworts (*Asplenium*), a few of the shield-ferns (*Aspldium*), the flowering-ferns (*Osmunda*), as well as the genera *Acrostichum*, *Onoclea*, etc. These include some of our largest and coarsest ferns.
- 13. In the second we find a few spleenworts, most of the shield-ferns, the beech-ferns (*Phegopteris*), most of the grape-ferns (*Botrychium*), the maidenhair (*Adiantum*), the *Dicksonia*, and some others. In this situation we find the finest development of foliage and the greatest artistic finish among all the ferns.
 - 14. In uncultivated places and on rocky hillsides, we often

find the common bracken or brake (*Pteris aquitina*), and the ladyfern (*Asplenium filix-fæmina*), though these are by no means confined to these locations, the latter growing quite frequently in mcist woods, and even in cold, wet swamps. Many other ferns are found occasionally in openings of the forest or recent clearings, where they maintain a sickly existence, sometimes for a series of years. In such locations, ferns often become contracted, and abnormal in growth, and lose their bright green color by exposure to the open sunshine.

- 15. In moist ravines and on rocky banks, the bladder-ferns (Cystopteris) may be found, with the peculiar walking-leaf (Camptosorus), the rare hart's-tongue (Scolopendrium),* and many of the smaller spleenworts. The long pendent fronds of *Cystopteris* bulbifera add greatly to the beauty of our natural ravines, and often serve to conceal the uncouth rocks, or at least draw the attention to that which is more delicate and artistic. On dripping rocks, or where the sides of ravines are kept continually moist by the spray of waterfalls, such delicate pellucid ferns as the filmyfern (Trichomanes) and Pellæa gracilis may be sought. There seems to be a direct connection between the environment and the texture of the fern. The last two mentioned grow in very damp situations, and are pellucid and almost membranous. Cystopteris, in somewhat drier situations is thinly herbaceous, while Asplenium Trichomanes and Camptosorus, requiring less moisture, are more firm, and form the transition to the next group which contains ferns often leathery in texture.
- 16. On dry cliffs we may look for the various species of Woodsia, the cloak-ferns (Notholæna), the lip-ferns (Cheilanthes) and the cliff-brakes (Pellæa). All these are peculiarly fitted to survive long periods of drought, and in some cases are specially provided with structural appendages for this purpose.
- 17. Only one of our native species is strictly aquatic, the anomalous *Ceratopteris thalictroides* found in Southern Florida, though *Acrostichum aureum* is often found with its rhizoma rising from the water of salt marshes. *Osmunda regalis* is occasionally found in standing water several inches deep though this is not usual.

^{*} This rare fern seems to show a decided preference for limestone rocks, and thus far has been found only above the geological formation known as the Corniferous limestone. I believe a thorough search for this fern along the outcrops of this formation in Central New York and elsewhere, would show a wider distribution than is at present attributed to this species.

- 18. Among the epiphytic ferns are several species of *Polypodium*, especially *P. incanum*, *P. Scouleri*, and *P. aureum*, the last always being associated with the cabbage-palmetto (*Sabat Palmetto*). *Vittaria*, *Tænitis* and *Nephrolepis* are also of this class and are frequently pendent from the same plant, though occasionally found on other tree-trunks. *Ophioglossum palmatum*, another peculiar tropical fern-ally, belongs to the same list.
- 19. These principles of climatic distribution are more or less modified by the geographic range of species, which must be considered in this connection. For example, *Aspidium spinulosum* or its varieties form the leading foliage ferns of Northern New England and New York, while *Dicksonia* less common in those localities largely replaces them in Connecticut and southward.
- 20. Geographic Distribution.—Ferns are found in all parts of the world. The number of described species is not certainly known, and the uncertainty is largely increased for the reason that our best systematists do not agree as to what constitutes a species. One of the best authorities describes 2646 species, though several recognized American species are not mentioned, and this is probably true of those of other countries.*

From what has been said respecting the climatic conditions of fern growth, we would naturally expect to find them most abundant in countries where warmth and moisture predominate. These conditions seem most completely met on tropical islands or in tropical continental areas with insular climates. The little island of Mauritius having an area of 676 square miles, or less than one-third the area of Delaware, has 235 native species, while Java, little larger than New York, has 460. Brazil furnishes 387, and the Isthmus of Panama 117. Comparing these with colder climates, we find 67 in all Europe, and only 26 within the borders of the arctic zone.

- "Our Native Ferns," as described later in this volume, including those species that are classed in the order FILICES number 144 species. Adding to these the II species of the order Ophio-GLOSSACEÆ which have frequently been enumerated with the ferns we have a total of 155 species.
- 21. Divisions of our Fern Flora.—It has been found convenient to divide the surface of the earth into faunas and floras.

^{*} Synopsis Filicum, or, A Synopsis of All Known Ferns. By Sir W. J. Hooker and J. G. Baker. Second Edition, London, 1874.

limited by the natural distribution of the various species of animals and plants. These limits are by no means sharply defined, for wherever the limit is made some species will pass beyond it; yet the majority found on one side are different from the majority of those on the other. North America (excluding Mexico), forms the Nearctic realm or fauna (*Regnum Nearcticum*), and the same boundaries may be used in the limitation of our fern flora, although some species from tropical regions invade our southern borders.

- Mr. J. H. Redfield has given us a distribution of our native species into six geographical divisions or subdivisions of the Nearctic realm, from which the following section is copied.*
- 22. "I. Cosmopolitan: widely distributed over the globe in both temperate and tropical regions.
- II. BOREAL: inhabiting (with a few exceptions) the northern portion of the United States, extending through Canada and British America, some species even reaching Labrador, Greenland and Alaska, and nearly all represented also in the northern portions of the Old World.
- III. APPALACHIAN: extending throughout the mountain and hilly region of the states east of the Mississippi, often to the coast, and northward into Canada, and in a few instances also inhabiting the Old World.
- IV. PACIFIC: extending along the western border of the continent at points from Alaska to California, in a few cases appearing also in the Rocky Mountain region.
- V. New Mexican: inhabiting the central mountain regions of New Mexico and Colorado, many of the species extending thence into Mexico, and some even to South America, and a few of them also occurring in California.
- VI. TROPICAL: inhabiting the border of the Gulf of Mexico, most of the species extending into the West Indies and Tropical America."
- 23. The distribution of our species can be seen from the following table:

^{*} Bulletin Torrey Botanical Club, January, 1875.

	Regions.	Species.	VARIETIES.	SPECIES PECULIAR TO NEARCTIC REALM.
I.	Cosmopolitan,	3		
II.	Boreal,	24	3	2
III.	Appalachian,	36	3	17
IV.	Pacific,	3 0	4	19
v.	New Mexican,	28		11
VI.	Tropical,	34	1	3
	Total,	155	11	52

For the distribution of individual ferns, and for the list of species peculiar to America, the reader is referred to the description of the species later in this work. Future discoveries will be likely to modify to some extent the limits there given. It will be noticed that those parts of our realm separated farthest from other countries contain the greatest number of peculiar species.

24. Local Lists.—The number of species found in a single locality is usually limited, yet in certain locations there is a marked diversity. As an instance, in one of the *habitats* of the rare hart'stongue,* the writer has collected twenty species illustrating nine genera within the radius of a stone's throw. Such localities, however, are comparatively rare and must include wide diversity of soil and shade within very narrow limits.

Onondaga county, N. Y., possesses perhaps as many ferns as any county in the entire country, 40 species having been catalogued. 32 are catalogued from Essex county, Mass. Several state lists more or less complete have been compiled and are noticed in Chap. IX. Carefully prepared lists from all the states and territories would be a valuable addition to our knowledge of geographic distribution.

25. Geologic Distribution.—It is well known that the plants and animals now existing on the earth are not the same in kind as those of former ages. Geologists have carefully studied the stony heart of nature, and have drawn therefrom the story of the development of land and sea, and the successive populations that

^{* &}quot;Green Pond," one mile east of Jamesville, Onondaga Co., N. Y.

from time to time have held possession of our globe. Plants furnishing the natural food for animals must have preceded animal life, yet, in the earliest geologic ages, the remains of animals are far more numerous. The abundance of the deposits of graphite and iron-ore in the earliest or Archæan rocks indicates the existence of extensive plant growth, but the remains are so transformed as to make it impossible to determine the character of this primeval vegetation.

- 26. In the succeeding Silurian age, the fossil remains indicate the existence of algæ or sea weeds in abundance, and a single small species of ground pine attests the existence of some of the higher *Cryptogamia*; no ferns, however, have been found in America older than the Devonian. Over fifty species of Devonian ferns have been described from the American rocks chiefly, by Dr. J. W. Dawson of Montreal.
- 27. It is in the coal measures, however, that ferns and other *Cryptogamia* are found in the greatest abundance and profusion. Their delicate foliage is impressed on the various rock strata above the beds of coal, and so perfectly are they preserved that not only the methods of fructification but even the microscopic spores have been detected! In the coal measures of the United States and Canada (counting from the base of the Catskill), three hundred and eighty-one species of ferns have been described, chiefly by Prof. Leo Lesquereux. The most abundant American genera are *Neuropteris* 45 species, *Pecopteris* 50 species, *Sphenopteris* 31 species, *Pseudopecopteris* 25 species, and *Rhacophyllum* 24 species.

The frontispiece gives an ideal representation of the vegetation of the Carboniferous age. The luxuriant tree-ferns, the *Lepidodendrids*, ancient representatives of the diminutive club mosses or ground pines, the *Calamites*, allies of the modern scouring-rushes, and other forms no less wonderful are seen in their profusion.

28. In the later geologic ages, Mesozoic and Tertiary, ferns are found preserved in the rocks, with the leaves of many trees and shrubs of existing genera. The indications are, that ferns formed a far smaller part of the vegetation of these later ages than in the preceding Carboniferous, and even approximated to that of the present. Six Cretaceous and twenty-four Tertiary species have been catalogued,* including species in the existing genera

^{*} Tenth report, Hayden Geological Survey of the Territories, Washington, 1878.

Lygodium, Pteris, Woodwardia, Aspidium, Gymnogramme, etc., as well as some related to genera abundant in earlier formations. No living species is found fossil, unless Dr. Newberry's variety of Onoclea sensibilis becomes established.* In the course of geologic history, however, we can trace a gradual approximation to the modern types from the generalized forms of Devonian and Carboniferous times.

^{*} Prof. Lesquereux writes me: "Though analogous by the nervation, I doubt the identity on account of the coriaceous character of that fossil fern, which I have not seen in any variety of O. sensibilis now living." Dr. Dawson however writes: "The Onoclea sensibilis of the Laramie is truly that species and I have found with it in our Manitoba formations another modern fern Davallia tenuifolia.

CHAPTER II

ORGANOGRAPHY OF THE GROWING FERN

Pour bien savoir une chose, il faut en savior les details.

—La Rochefoucauld.

- 29. Every one familiar with the forest and its products must have seen the young ferns unrolling from the bud in spring and early summer. It will be noticed that the fronds are coiled from the apex to the base, and form croisers, so called from their resemblance to the head of a bishop's staff. This method of vernation is called *circinate*, and is rarely found except among ferns. In the grape-ferns and adder-tongues, the vernation is straight or merely inclined, thus approximating that of ordinary flowering plants.
- 30. Rootstock.—Ferns usually spring from an underground stem called the *rootstock*. This may be simple or branched, smooth or scaly, horizontal, oblique, or even vertical. In some ferns it is fine and hairlike, while in others it is very large and stout. In some cases the rootstock creeps at the surface of the ground and even rises above it, as in the variety of Aspidium conterminum recently discovered in Florida. In the tree ferns of warmer climates it often forms a trunk fifty feet high bearing the fronds at the summit when it takes the name of caudex.
- 31. Frond.—The aerial portion consists essentially of a leaf-stalk and blade; the former is technically called the *stipe*, and the latter the *frond*. Though these are usually distinct from each other in appearance, the stipe is sometimes wanting, and in others no distinction can be made between them. Both stipe and frond, or either one, may be glabrous (smooth), pubescent (softly hairy) hairy, woolly or scaly. When the scales are small and somewhat appressed, the surface is said to be squamous. In a few of our native ferns the under surface is covered with a white or yellow powder bearing some resemblance to flour or corn-starch. For this reason a surface of this character is called *farinaceous*. Such is the California gold-fern or "golden back" (*Gymnogramme triangularis*), and several of the cloak-ferns (*Notholæna*), and such are the various gold and silver ferns of conservatories, including some of the richest and most beautiful in the world.
 - 32. The frond may be simple when it consists of a single un-

divided leaf, or *compound* when it is divided into segments. The exquisite delicacy and the extent to which this dividing is carried in some ferns gives to them their chief æsthetic value.

The continuation of the stipe through a simple frond is called the midvein; through a compound frond is called the rachis, and is further distinguished as primary when the frond is much compounded. A frond is *entire* when the margin forms an unbroken line; when so cut as to form lobes extending half way or more to the midvein it is called *pinnatifid*: when these incisions extend fully to the midvein the frond is said to be simply pinnate and the divisions are called pinnæ. When the pinnæ are cut into lobes the frond is bibinnatifid and the lobes are called segments, and when these extend to the secondary midveins it is bibinnate and the divisions are called pinnules. The secondary midvein then becomes a secondary rachis. In like manner we may have ferns that are tripinnatifid and tripinnate, quadripinnatifid and quadripinnate. The last lobes are designated ultimate segments and the last complete divisions ultimate pinnules. All these various forms from entire to quadripinnate are abundantly represented among our native ferns.

- 33. In some pinnate fronds, as in the oak-fern (*Phegopteris Dryopteris*), the lower pair of pinnæ is greatly enlarged and more compound than those above, so that the stipe appears to form three branches bearing similar and nearly equal portions. Fronds of this character are usually triangular or pentagonal in outline and this method of branching is called *ternate*. It will be readily seen that this is merely a modified form of the ordinary pinnate frond. Throughout the domain of nature there is infinite variety of form and structure and at the same time, unity in plan and conformity to a few generalized types of structure.
- 34. Venation.—The method of veining admits of great variation, often serving to distinguish species and more especially the sections of the various genera. In some ferns, like most shield-ferns (Aspidium), the veins are free, that is arising from either side of the midvein they do not unite with any other vein. In some of these the vein is simple (not branched), in others variously forked. In many the veins repeatedly anastomose or unite together forming a series of network or areolæ. This may be somewhat irregular as in Onoclea, or forming a single row of areolæ next to the midvein and thence free to the margin as in Woodwardia Virginica, or forming many uniform areolæ by the parallel transverse veinlets connecting the distinct and parallel primary veins as in Polypodium Phyllitidis.

CHAPTER III

FRUCTIFICATION IN FERNS

"But on St. John's mysterious night, Sacred to many a wizard spell, The hour when first to human sight Confest, the mystic fern-seed fell."



Fig. 1. Enlarged section through a sorus of Polypodium falcatum, Kellogg, showing the stalked sporangia. (Original.)

Spores and Sporangia. -In the flowering plants (PHA-NEROGAMIA) there is a manifest sexual reproduction, the ovules in the female organs (pistils) being fertilized by the pollen produced by the stamens, thus giving rise to the embryo of the

new plant. The Cryptogamia on the contrary produce no flowers. Instead of seeds developed from fertilized ovules, minute spores are produced asexually from which new ferns are developed by a peculiar process of germination very unlike that of flowering plants. These spores are collected in little sacs known as sporangia or capsules. The sporangia in the true ferns (POLYPODIACEÆ) are collected in little clusters on the back of the frond or are variously arranged in lines along the veins or around the margins. (Fig. 1).



These clusters of sporangia are called sori, and may be naked, as in Polypodium, or provided with a special covering known as the indusium or involucre, as in Aspidium (Fig. 9). The various forms of the sori and indusia serve as the basis for classification into genera and tribes, while each sub-order has its peculiar form of sporangia.

36. In the Polypodiace the sporangia are more or less completely surrounded with a jointed vertical ring or annulus and at maturity burst open transversely by the straightening of the annulus and discharge their copious spores (Fig. 2). The clusters of sporangia may be marginal, intramar-Fig. 2. Sporangium ginal or dorsal, according as they have their posiof Polypodium vul-tion at the margin or more or less remote from it. gare, L. discharging thom at the margin of more or less remote from it. its spores. Much en-

larged. (Original.) or arranged in variously forking lines, or may even

be spread in a stratum over the entire under surface of the frond. They may be indusiate or non-indusiate according as they are covered or naked; and the indusia may be inferior (attached below the sorus), as in *Woodsia* (Fig. 11), or superior as in *Aspidium* (Fig. 10), or of various intermediate methods of attachment-







Fig. 3.

Fig. 4.

Fig. 5

Fig. 3.—Enlarged sessile sporangium of *Trichomanes radicans*, Swz. (Original.)
Fig. 4.—Sporangium of *Scihzæa pusilla*, Pursh, showing the apical ring. Much enlarged. (Original.)

Fig. 5.—Sporangium of Osmunda regalis, L., showing the rudimentary ring. Enlarged. (Original.)

37. In the other sub-orders of FILICES the sporangia are variously arranged. In the HYMENOPHYLLACEÆ or filmy ferns the flattened sporangia are sessile along a filiform receptacle and are surrounded with a complete transverse annulus. At maturity they open vertically. (Fig. 3). In the SCHIZÆACEÆ the sporangia are ovate, surrounded at the apex by a complete annulus, and open by a longitudinal slit. (Fig. 4). In the OSMUNDACEÆ or flowering ferns the sporangia are larger, globose and naked, with the mere trace of a transverse annulus, and open longitudinally. (Fig. 5).

The various methods of fructification can be best understood by describing the peculiarities of the various genera in regular succession and noting the variations occurring in the sections or sub-genera. By this means we will arrive at a better understanding of the principles of fern classification as discussed in a future chapter. As the subject of venation is closely connected with that of fructification, it will be treated in the same connection.

- 38. Acrostichum.—In this genus the sporangia are spread in a stratum over the under surface of the upper pinnæ in our solitary species, but in some exotics they cover portions of the upper surface as well. There is no indusium.
- 39. Polypodium.—(Fig. 1). This genus contains the largest number of existing ferns, and though all the species agree in the roundish naked sori, the venation is widely different in the various sections which are chiefly formed on the character of the veins. Four of the five sections are represented in our nine species.

In Eupolypodium the veins are free, yet are occasionally known to unite,* thus indicating a tendency to vary toward the next section. The sori are generally found at the end of a free veinlet.

In Goniophlebium the veins unite near the margin forming large areolæ, each containing a single free veinlet which bears the sorus at its end. A tendency to variation is seen in *P. incanum* in which the veins are free, as well as in *P. Californicum* in which they are often partly free.

In Phlebodium the veins form ample areolæ in a row next the midvein and frequently in one or more secondary rows, each bearing a single sorus at the junction of two or more veinlets. A large number however bear the sori at the end of a single veinlet. From the fertile areolæ to the margin the veins anastomose more copiously.

In CAMPYLONEURON the areolæ each usually bearing two sori, are found between the parallel primary veins which extend from the midrib to the margin.

- 40. Gymnogramme.—In this genus the sori follow the course of the veins and consequently vary with the venation, being simple, forked, pinnated or anastomose with each other. The sori are non-indusiate.
- 41. Notholæna.—In the cloak-ferns the sori are marginal and provided with no indusia. This genus is linked very closely to *Gymnogramme* on one hand and to some species of *Cheilanthes* on the other. From the latter it is scarcely separable and the two are likely to be confounded by beginners.
- 42. Tænitis has simple fronds and the fructification in a continuous sub-marginal line near the apex of the frond.
- 43. Vittaria.—This peculiar genus occupies a somewhat intermediate position between the indusiate and non-indusiate genera, and while usually associated with the latter has considerable claim to be ranked with the former. The fronds are narrow and grasslike, bearing the sporangia in an intramarginal groove, often more or less covered by the inrolled edge of the frond. The venation is very obscure.
- 44. Adiantum.—The maidenhairs have a peculiarly smooth foliage and usually possesses no midvein. The veins are usually flabellate, and after forking one or more times bear the sori at their extremities. The margin of the frond is reflexed thus form-

^{*} Catalogue of the Davenport Herbarium, p. 8.

ing an indusium which bears the sporangia on its under surface.

45. Pteris.—(Fig. 6). In this genus, which includes the common brake, the otherwise free veins are united by a filiform receptacle which bears the sporangia. This continuous marginal line of fructification is covered by a membranous indusium formed of the mar- receptacle under the marginal indusium. gin of the frond.

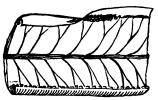


Fig. 6. Pteris longifolia, L. Enlarged segment of pinna showing the vein-like (Original.)

46. Cheilanthes.—The lip-ferns found within our limits are unequally divided among four sections, all agreeing in bearing the sori at or near the ends of the veins covered by an indusium formed of the margin of the frond.

In Adjantopsis the indusia are distinct and confined to a single veinlet. Our species varies from the typical species of this section and has even been assigned to a separate genus.

In Euchellanthes the indusia are more or less confluent but not continuous, usually extending over the apices of several veinlets.

In Physapteris the ultimate segments are bead-like, and the indusium is continuous all round the margin.

ALEURITOPTERIS has the fronds farinose below, and includes a single species somewhat doubtfully assigned to our limits.

- Cryptogramme has dimorphous fronds, the margins of the fertile being closely rolled toward the midvein thus covering the confluent sori. At maturity these open flat in order to discharge the spores.
- 48. Pellæa has representatives of three sections within our limits all agreeing in possessing intramarginal sori which finally become confluent and form a marginal line covered by an indusium formed of the margin of the frond.

CHEILOPLECTON includes herbaceous species with visible veins and broad indusia.

Allosorus includes coriaceous species having wide indusia. while Platyloma includes species similar in texture but with extremely narrow indusia and broad segments.

49. Ceratopteris is an anomalous genus having a few sori arranged on two or three veins parallel to the midvein and covered by the broadly reflexed margin of the frond.



Fig. 7. Lomaria spicant, Desv. Enlarged section of the contracted fertile pinna showing intramarginal indusium. (Original.)

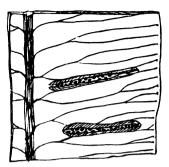
- 50. Lomaria (Fig. 7) stands intermediate between those genera in which there is an indusium formed of the revolute margin of the frond and those in which the indusium is remote from the margin. Our single species has dimorphous fronds, free veins and the fructification in a broad band next the midvein, covered by a continuous and distinctly intramarginal indusium. This genus closely resembles the next in general habit and is sometimes united with it.
- (Original.) 51. Blechnum.—In this genus the sori are linear and near the midvein, and are covered by a membranous indusium which is fixed at its outer margin, bursting at its inner margin when the sporangia are mature. A single representative is found within our limits.
- 52. Woodwardia.—Three species of chain-ferns occur within our limits, and each represents a distinct section based on the methods of venation. All have oblong or linear sori more or less sunken in the frond, covered by special lid-like indusia bursting at their inner margins, and arranged in chain-like rows near the midvein thus giving the popular name to the genus.

EUWOODWARDIA has uniform fronds and veins forming at least one series of areolæ between the sori and the margin.

ANCHISTEA has also uniform fronds but with free veins from the sori to the margin, while LORINSERIA has dimorphous fronds and the veins everywhere uniting to form areolæ, as in the sensitive-fern (Onoclea sensibilis).

53. Asplenium.—The numerous species of spleenworts are closely related to each other in their methods of fructification but differ widely in the form, texture and cutting of their fronds. The sori are placed on the upper side of an oblique vein (sometimes crossing it in Athyrium) and covered by an indusium of the same shape attached by its edge to the fruiting vein and opening toward the midvein. In some species part of the indusia are double. The veins are free in all our species. In Euasplenium the sori are straight or slightly curved; in Athyrium they are often curved, even horseshoe shaped and frequently cross to the outer side of the fruiting vein.

- 54. Scolopendrium (Fig. 8) bears the linear sori in pairs, one from the upper side of a veinlet and its mate from the lower side of the next. The indusia are attached by their edges to the veins, and folding toward each other appear like a double indusium covering a single sorus. The veins extend nearly at rightangles to the midvein, are free and usually forked.
- 55. Camptosorus.-The walking-leaf has oblong or linear in- Section of frond showing venation and dusiate sori, which are irregularly scattered and borne partly on veins parallel to the midvein,



Scolopendrium vulgare, Sm. fructification. (Original.)

and partly on those that are oblique. Those near the midvein are single, those toward the margin are often approximate in pairs and often form crooked lines. The veins are everywhere copiously reticulated.

- 56. Phegopteris.—In this genus the sori are round and naked as in Polypodium with which this genus is sometimes united. The sporangia spring from the back of the veins instead of the apex as in the latter genus and the veins are free.
- 57. Aspidium is largely represented in our limits by two well marked sections which are sometimes regarded as distinct genera, and two others with characters scarcely less distinct containing each a single species. In all the sori are roundish and borne on the back of the veins or rarely at their apex. In NEPHRODIUM the indusium is cordato-reniform or orbicular with a narrow sinus. This at first covers the sorus and is attached by its margin, but later bursts away at the margin but remains attached at the sinus. In some species in this section the indusium becomes shriveled before the fruit matures and in this condition might be mistaken for a non-indusiate species (Fig. 9).

In Polystichum the indusium is orbicular and peltate being fixed by the centre; the veins are free as in NEPHRODIUM (Fig. 10).

In CYRTOMIUM the indusium is the same as in POLYSTICHUM, but the veins tend to unite near the margin, while in Euaspidium the veins anastomose copiously.



Fig. 9. Aspidium (Nephrodium) rigidum, Swz., var. argutum. D. C. E. Enlarged segment showing indusia. (Original.)

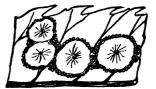


Fig. 10. Aspidium (Polystichum) munitum, Kf. Enlarged section showing indusia. (Original.)

- 58. Nephrolepis has roundish sori borne at the apex of the upper branch of a free vein, near the margin of the frond. The indusia are usually reniform fixed by the sinus or base and open toward the margins of the pinnæ.
- 59. Cystopteris.—The bladder-ferns take their popular name from the delicate, hood-like indusium which is attached by its broad base on the inner side of the roundish sorus and partly under it. Later this is thrown back and withers away. The veins are free and the fronds have the aspect of species of *Aspidium*, but are usually more delicate in texture.
- **60. Onoclea.**—This genus contains two quite dissimilar species which, until recently, have been separated into two genera by American botanists. Both have dimorphous fronds, the margin of the contracted fertile frond being strongly revolute and concealing the fruit. *O. Struthiopteris* has necklace-shaped pinnæ, crowded confluent sori, and free and simple veins. *O. sensibilis* has panicled berry-shaped pinnules and copiously anastomosing veins.



Fig. 11. Woodsia obtusa, Torr. Enlarged section of pinnule showing venation and inferior indusia. (Original.)

61. Woodsia (Fig. 11) has roundish sori borne on the back of the veins with the indusia attached beneath the sporangia and flat and open or early bursting at the top into irregular laciniæ or lobes. In Euwoodsia the indusia are flat and open from an early stage with their cleft and ciliate margins concealed under the sori. In Hypopeltis the indusium is more con-

spicuous and encloses the sporangium at first but soon bursts at the top forming several jagged lobes.

62. Dicksonia.—In this genus the small globular sorus is borne

in an elevated, globular receptacle and enclosed in an inferior, membranous, cup-shaped indusium. The veins are always free.

- 63. Trichomanes (Fig. 12) has sessile sporangia borne on a filiform receptacle at the summit of a vein. The indusia are tubular or funnelshaped with an expanded and often somewhat two-lipped mouth.
- 64. Lygodium.—In our species of climbing-fern the fructification is borne on contracted, forked pinnules occupying the upper portion of the frond. The ovoid sporangia are solitary or occasionally in pairs and are borne in the axils of the large, imbricated, scale-like indusia which are fixed
- by their bases to short, oblique veinlets. 65. Aneimia.—In this genus the two lowest branches of the frond bear panicles of fruit at the end of very long stalks. The ovate sporangia are sessile in two rows along the branchlets of the panicle without special covering of any kind. In the section represented by our species the veins are free.
- Schizæa.--In this genus the large ovoid sporangia are sessile in double rows along the single vein of the narrow fertile divisions. In our species the pairs of fertile pinnæ form a distichous spike. (Fig. 13).
- 67. Osmunda has the large globose sporangia, short-stalked and borne on the contracted fertile portions of the frond. In the cinnamon-fern (O. cinnamomea) the fertile fronds are entirely distinct from the sterile, yet manifesting a tendency to variation in the var. frondosa. In the interrupted flowering-fern (O. Claytoniana), the fructification is confined to a few of the middle pinnæ of the frond. In the royal flowering-fern (O. regalis) the fructification is borne at the apex of the fronds.
- Spores.—The spores of ferns constitute the fruit proper. A spore consists of two distinct pusilla, Pursh. Enclosed sacs and the cell contents, all of which tire plant natural differ from each other in chemical composition. size. (Original.)



Fig. 12. Trichomanes radicans Enlarged section showing method of fructification. (Original.)



The outer layer (exospore) consists chiefly of cellulose; the inner layer (endospore) contains some albuminous matter in addition, while the cell contents consist chiefly of a thin, colorless, jelly-like substance known as protoplasm, with grains of chlorophyll (the green coloring matter of plants), starch and oil. The exospore may be smooth or roughened by points, granules, warts or prickles. The shape varies with different species yet all are rounded, and most are oblong or at least longer than broad. All are microscopic and many are of such a shape that they do not appear uniform, owing to the various directions from which we view them. (Fig. 14-21).



Fig. 14-21. Spores, highly magnified. Cryptogramme acrostichoides, R. Br., Lygodium palmatum, Swz., Cystopteris fragilis, Bernh., Schizæa pusilla, Pursh.

Acrostichum aureum, L., Polypodium Californicum, Kf., Gymnogramme triangularis, Kf., Notholæna candida, Hook. (Original.)

69. The number of spores produced by a single fern is incredible. Lindley calculated that a single frond of *Scolopendrium* produced about 80 sori, with an average of 4500 sporangia in each sorus, and each sporangium containing 50 spores, making a total of 18,000,000 spores. The copious green spores of *Osmunda cinnamomea* or the pale yellow, powdery spores of a well developed specimen of *Botrychium Virginianum* must far exceed this computation.

CHAPTER IV

GERMINATION OF FERN SPORES

Alle Glieder bilden sich aus nach ew'gen Gesetzen,
Und die seltenste Form bewahrt im Geheimniss das Urbild.
—GOETHE.

- 70. The germination of the fern spores usually takes place a considerable time after they are discharged from the sporangia, but in *Osmunda* which develops its fruit early in the season they commence their growth only a few days after dissemination.
- 71. Thalloid Phase. (Sexual Generation).—In germination the exospore splits along the side and the protruding endospore, sometimes with its divisions already formed by septa or partitions, forms, not a fern, but a thalloid structure resembling a lichen or marchantia, called the *prothallium*. Different ferns vary in the method of forming this prothallium, some producing it immediately at the spore and others after the formation of a thread-like

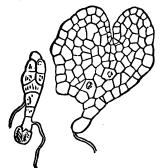


Fig. 22-3. Prothallium of *Pteris ser-rulata*, Linn. f., showing two stages of growth. (After Moore.)

growth known as the pro-embryo. The prothallium is entirely composed of cellular tissue, and in the true ferns (Polypodiaceæ) is broadly cordate or reniform in shape, and bears large numbers of root-hairs from the under part of its posterior portion (Fig. 22-3.) The prothallium seldom exceeds one-tenth of an inch in length. On the under surface of the prothallium two sorts of organs are produced analagous to the stamens and pistils of the Phanerogamia, respectively known as antheridia and archegonia. The position of these organs on the prothallium varies in different sub-orders.

72. Antheridia.—These are small masses of tissue developed in the same manner as the root-hairs, consisting of a single layer of cells forming the wall and containing a number of spirally coiled threads usually with a number of cilia on their anterior

coils. At maturity the antheridium swells by the absorption of



Fig. 24. Antheridium of Adiantum Capillus - Veneris, L., showing the escaping antherozoids. (After Sachs.)

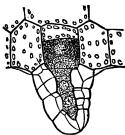


Fig. 25. Young archegonium of *Pteris serrulata*, Linn. f., showing oosphere, neck and canal-cell. (After Sachs.)

water and finally bursts its wall, discharging these coiled filaments which possess the power of locomotion, and for this reason are called *antherozoids*. These antherozoids often drag with them a little vesicle which seems to play no part in the process of reproduction. (Fig. 24).

73. Archegonia. - The archegonium (sometimes called pistillidium), is also a rounded mass of tissue usually less prominent than the antheridia, consisting of an external layer of cells and a large central cell which soon divides into two. The lower portion, at first the larger, develops into a roundish cell, which is analogous to the ovule of flowering plants and is called the oosphere. The upper portion of the central cell develops between those composing the neck of the archegonium into a canal filled with a sort of mucilage; this finally swells up, forces the cells of the neck apart, and is expelled to aid in attracting and retaining the antherozoids at the neck of the archegonium. The oosphere is thus left exposed. (Fig. 25).

74. Fertilization.—The antherozoids, analogous to the pollen of flowers, when discharged from the antheridium, swim in the moisture always present on the under surface of the prothallium, swarm in large numbers around the neck of the archegonium and are retained by the mucilage. Some finally force their way into the canal of the neck, a few reaching the oosphere and disappearing within its substance. There is thus a true sexual generation among ferns, and the formerly appropriate term, Cryptogamia (hidden marriage) loses its application under the untiring scrutiny of the microscopist. After fertilization the neck of the

archegonium closes and the fertilized oosphere, now called the oospore, increases in size and finally develops into a true fern.

75. Pteridoid Phase. (Asexual Generation).-After the oosphere has been fertilized it commences its growth by the ordinary processes of cell multiplication and for a time remains within the walls of the archegonium, which continue to grow, until finally the interior growth breaks through the walls, differentiated into its first root and leaf. The young fern draws its nourishment from the prothallium for a time but soon develops root-hairs which, extending into the soil, maintain thereby an existence independent of the prothallium. The latter growth having accomplished its work withers away. (Fig. 26.) The first parts of the root, stem and frond are very small and comparatively simple in structure, but those formed later are successively larger, and not only bear a closer resemblance to the mature form of the species, but also develop increased complexity of structure. "The fern continues to gain strength, not by subsequent increase of size of the embryonic structures, but by each successive part attaining a more considerable size and development than the preceding ones, until at length a kind of sta-



Fig. 26. Adiantum Capillus-Veneris, L. Prothallium and young fern seen from below: pp, prothallium; b, first leaf; h, roothairs of prothallium; w, w', first and second roots. (After Sachs.)

are nearly similar to the preceding ones." 76. The complete life history of a fern illustrates a principle common among the lower forms of animal life known as "alternation of generations." Instead of the direct production of a mature sexual plant, as among the higher forms of vegetation, there is the production of a sexual growth resembling a lower form of vegetation, which in turn is followed by the growth of a mature plant producing its fruit without the assistance of sexual organs.

tionary condition is arrived at in which the newly formed organs

Recapitulation.—To review the life history of a fern we find the following processes:

A. Production of the spores asexually by the mature plant. (FRUCTIFICATION).

B. Growth of the prothallium from the spore with or without the development of a pro-embryo. (THALLOID PHASE. SEX-UAL GENERATION*).

- C. Production of sexual organs, archegonia (female) and antheridia (male), on the under surface of the prothallium.
- D. Fecundation of the oosphere developed in the archegonium by the antherozoids developed in the antheridium. (Fertilization).
- E. Growth of the mature fern in successive stages from the oospore. (Pteridoid Phase. Asexual Generation*).

^{*}The term "generation" in the above sense, although in common use by the best botanical writers is decidedly unfortunate and misleading. A generation is properly the production of offspring resembling the parent, or the offspring thus produced, which the prothallium is not and the mature fern is not. The generation proper must then be considered as including the entire life history of a fern of which the prothallium and mature fern are successive phases. The terms "sexual" and "asexual" as used in this connection are likewise misleading as they might apply as well to the origin as to the producing power of the so-called "generation." The prothallium is asexual in origin but develops sexual organs; the mature fern on the other hand produces no sexual organs, but is itself the product of bisexuality. I suggest the terms Thalloid phase and Pteridoid phase for sexual and asexual generation. The same criticism applies with equal force to the use of the expression "alternation of generations" by zoologists.

CHAPTER V

FERN STRUCTURE

Be it ours to meditate,

And to the beautiful order of thy works

Learn to conform the order of our lives.

—BRYANT.

- 78. Tissues.—The life history of every plant commences in a single cell, and all the complications of vegetable growth depend on two simple processes, viz: the enlargement of individual cells to their full size, and their multiplication by division. The lowest forms of vegetable life consist of a single cell, either globular or elongated. Those of a somewhat higher grade consist of a single row of cells, or at most a single layer; while still higher forms of growth consist of masses of cells variously grouped together and specialized by differentiation from the typical form and character.
- 79. Cells become specialized or set apart to fulfil a certain function in the economy of plant growth in many ways. Some are lengthened for giving strength to stems or leaves; some have their walls thickened to give hardness where protection is needed from injury to more delicate structures within; and some are variously adapted for containing and distributing the secretions or other fluids connected with the circulatory system of plant life. Seven distinct varieties of tissues are recognized by structural botanists yet some of these are connected with each other by various gradations.*
- 80. Tissue Systems.—The earliest tendency to differentiation of cells is seen in the arrangement of the outer row of cells to form a boundary wall. In higher forms of growth the interior cells tend to form one or more series of string-like rows surrounded by the normal cellular tissue. We thus reach the basis of the classification of vegetable tissues into three groups: (a). Epidermal System. (b). Fibro-Vascular System. (c). Fundamental System. (Fig. 27). The first and third are common to both ferns and mosses. The second is first seen in the ferns and their allies, where it is a character so constant that it serves as the basis for separating the so-called "vascular" Cryptogamia from

^{*} Those desiring more extended information on this subject are referred to Chap. VI in Bessey's Botany where the subject is clearly and systematically treated.

other flowerless plants. These three forms of tissue may be seen by examining a thin cross section of the stipe of a living fern with the microscope.

- 81. Roots.—Roots are constantly produced as the rootstock advances, and consist for the most part of little fibrils which are naked for a short distance from the apex in order that they may freely absorb moisture from the earth. The epidermis is also thin and usually consists of a single layer of small cells. It differs from that of the rest of the plant in having no stomata (86). As the apex continues to grow, the epidermis of the part behind becomes harder and frequently develops hairs or more frequently irregular scales.
- 82. Stipe.—The stipe is made up of the three forms of tissue. (Fig. 27), and usually contains several bundles of vascular tissue. In the dried stipe these can be easily examined, by scraping off the external covering of the stem. These bundles of fibres give stability to the fern and are continued through the rachises and veins thus forming topteris fragiles, Bernh., showing two bunthe framework for the softer por- dles of fibro-vascular tissue. (Original.)

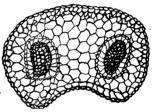


Fig. 27. Cross section of stipe of Cystions of the frond. The stipes are sometimes smooth and polished. sometimes hairy or beset with stalked glands, and sometimes densely clothed, especially near the base, with chaffy scales.

- 83. Frond.—In the HYMENOPHYLLACEÆ, the frond consists of a single layer of cells. This condition is also found in the leaves developed along the axis of growth among the mosses to which this sub-order is related in some of its forms. In all other ferns there are several layers of cells variously compacted together and forming all the varieties of texture, membranous, herbaceous, coriaceous and fleshy. The epidermis is usually easily separable from the underlying tissue, when its peculiar markings can be studied.
- 84. From the epidermis a great variety of appendages are developed which are all modifications of hairs and are all included under the term trichomes, however different in appearance or distinct in function. These are not confined to the frond but develop here their greatest variation. They are frequently found on the roots, the rhizoma and the stipe, under the form of root-hairs or

scales of various forms. Scales are especially abundant in certain forms of *Aspidium*, as well as in *Scolopendrium* and other genera.

- 85. Trichomes.—On the fronds the trichomes may be developed as simple unarticulated or articulated hairs, consisting of one or two cells at most. They may appear as stalked glands like those that arise from the stipe of Cheilanthes Cooperæ or the margin of the indusium of Aspidium spinulosum, var. intermedium; or they may be developed into scales of intricate cellular structure like those on the under surface of certain forms of Cheilanthes, particularly C. Fendleri and C. Clevelandii. Among the FILICES the sporangia are specialized trichomes developed in clusters (sori) along the veins, or spread over the entire surface of the frond, or even arranged in spikes or panicles. The epidermis also develops an excrescence known as the indusium, which consists of a single layer of cells, and is variously arranged as indicated in Chapter III. In some cases a false indusium is provided which is not a growth from the epidermis and may consist of several layers of cells.
- 86. Stomata.—If the epidermis covering the under surface of a fern be examined under a high magnifying power, peculiar structures will be seen in the form of semi-elliptical or crescent shaped cells connected at their apices and separated between. These are the stomata or breathing pores, and are merely openings to the air chambers of the plant. The two elliptical cells form the mouth of the passage and expand when moist, allowing the atmospheric gases and watery vapor to escape or enter, but close the entrance by contraction in time of drought. The stomata are not confined to the fronds but are found to a greater or less extent on all aerial portions of ferns and higher plants as well as on subterranean stems. In many of our species of *Cheilanthes* and *Notholæna* there is an additional provision against drought in the copious tomentum or chaff which is borne on the under surface of the fronds.
- 87. Asexual Reproduction.—Besides the ordinary methods of sexual reproduction discussed in Chapter IV, most ferns are propagated by growth of the rootstock under ground giving rise to a succession of fronds each season. In addition to this which is common to all perennial plants, there are some methods of reproduction that deserve attention. The first is by
- 88. Buds and Bulblets.—In a few species of conservatory ferns adventitious buds are produced on the surfaces of the fronds. These soon develop into young ferns and it is not uncommon to

see a large number in various stages of growth rising from a single frond. This peculiarity is common among several species of Asplenium, especially A. furcatum. Thunb., and will sometimes be found to occur among some of our native species. Bulblets are found in the axils of the upper pinnæ of Cystopteris bulbifera which often fall to the ground and develop into new plants after a manner analogous to the development of the axillary buds of the tiger lily.

89. Another method is seen in the walking-leaf (Camptosorus rhizophyllus) in which the long, attenuated, simple fronds bend over and take root in the adjoining soil in a manner quite analogous to the propagation of strawberries by runners. (Fig. 28). The same method of rooting at the apex has recently been culiar method of propagation noticed in Asplenium pinnatifidum.*



Fig. 28. Camptosorus rhizophyllus, Link., reduced, showing pe-(Original.)

CHAPTER VI

THE FERN ALLIES

Beneath my feet The ground-pine curled its pretty wreath.

-EMERSON.

THE GRAPE FERNS AND ADDER-TONGUES.

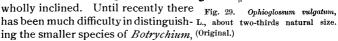
go. General Characters.—These peculiar plants formerly united with the order FILICES are now regarded as constituting a distinct botanical order. They include mostly small, fleshy, terrestrial plants and like ferns may usuall be found in swamps or rich

^{*} D. C. Eaton in Torrey Bulletin for September, 1880.

moist woods. As already noticed (5) there is a marked tendency to variation in the same species and numerous varieties have been established from the various forms.

gr. The sterile and fertile portions of the plant are borne on a common stalk and either portion may be sessile, long or short-stalked in the various species. In Ophioglossum the sterile portion is simple and in all our species except the anomalous O. palmatum appears like a single leaf borne on the common stalk. (Fig. 29). In Botrychium the sterile segment (except in some forms of B. simplex) is somewhat pinnately or ternately divided and in the larger forms of B. Virginianum is broadly ternate with the divisions even tri-quadripinnatifid. The veins are free in the latter genus but anastomose in the former. This character, however, is frequently obscured by the fleshy texture of the plant.

92. Vernation.—As has been before stated, ferns are rolled in the bud from the apex downward (circinate), distinguishing them from the higher forms of vegetation. Among the OPHIOGLOSSACEÆ, however, the vernation is either straight, inclined at the apex of one or both segments, or else the fertile segments are folded on the main stalk, making the vernation wholly inclined. Until recently there has been much difficulty in distinguish- L., about two-thirds natural size.



and some forms seem to connect the smaller ones with the reduced forms of B. ternatum and B. Virginianum.

The publication of a series of distinguishing characters with illustrations by a specialist in this genus,* has added much to our

^{*} Vernation in Botrychia, by Geo. E. Davenport. Bulletin Torrey Botanical Club, Jan. 1878, from which the cuts in this work are copied. See also Bulletin, Nov. 1880.

positive knowledge of these intimately related species, and has made their identification a matter of comparatively easy investigation. The buds may be found enclosed in the base of the common stalk (except in B. Virginianum where they are placed in an upright cavity at one side) and may be examined with a strong lens. The three divisions are summed up as follows:

"I. Vernation wholly straight. B. simplex, Hitch. (Fig. 41).

II. Vernation partly inclined in one or both portions. B. lunaria, Swz., (Fig. 42), B. boreale, Milde, B. matricariæfolium. A. Br., (Fig. 43), and B. ternatum, Swz. (Fig. 44).

III. Vernation wholly inclined, in the fertile frond recurved. B, lanceolatum, Angs., (Fig. 45), and B. Virginianum, Swz."

The special characters of each species will be found under the descriptions of the Botrychia later in this work. The cuts will be valuable for reference, and will enable even beginners to identify the species of this complicated genus with comparatively little difficulty.

93. Fructification.—In this order of plants the fructification consists of sporangia which unlike those of the true-ferns are not reticulated, possess no trace of a ring, open by a transverse slit, and are variously spiked and panicled. (Fig. 30). In the adder-tongues (Ophioglossum) the sporangia are large and cohere in two ranks along the margins of a single spike, opening transversely to discharge their copious sulphur-yellow spores. In the grape-ferns (Botrychium) the sporangia are globular and arranged in double rows along the narrow segments, more or less in panicles. In both genera the sporangia are not de-sporangia of veloped from the epidermal cells, but arise from a transformation of the interior tissue of

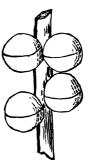


Fig. 30. Enlarged chium ternatum, Swz. (Original.)

the leaf. This with other characters as clearly defined serves to separate these anomalous plants from the order FILICES.

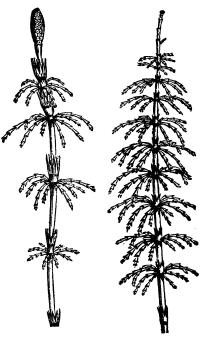
04. Germination.—Among the Ophioglossace so far as known the prothallia are destitute of chlorophyll, develop under ground and are monœcious, as in the FILICES. In Botrychium lunaria the prothallium is an ovoid mass of cellular tissue, light brown without and vellowish white within. It produces a number of antheridia and archegonia on the upper surface as well as the lower, differing in a few minor points from the true ferns in the method of their development.

95. Geologically this order dates back only to the Tertiary, one species of Ophioglossum having been reported from rocks of that age.

B. THE HORSE-TAILS.

96. General Characters.—The horse-tails or scouring-rushes belonging to the genus *Equisetum* are perennial, rush-like plants that may be found in damp, gravelly or loamy soil, or some species even growing in shallow water. Our native species vary in

height from a few inches up to eleven feet as seen in some of the larger forms of E. robustum. In some species only the root is perennial, the stems which are sent up for producing fruit dying down to the ground every year. In others the stems are evergreen continuing through the winter. Some species like the common horse-tail (E. arvense) are dimorphous, the fertile stems being simple and destitute of green coloring matter (chlorophyll), while the sterile stems are green and copiously branched. The fertile stems of some other species, as E. sylvaticum, which are simple at first, after maturing their fruit produce branches and resemble the ordinary ste- Figs. 31-2. Equation 1. (From Thome.)



Figs. 31-2. Equisetum sylvaticum, L., showing ster-

97. The furrowed stems are hollow except in E. scirpoides and in addition to the large central cavity there is a series of smaller air-cavities opposite the furrows known as the vallecular canals, the furrows themselves being called valleculæ and the

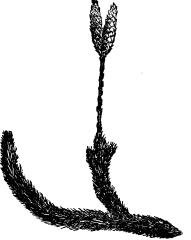
ridges carinæ. Opposite the carinæ there are still smaller cavities known as carinal canals. The carinæ vary in number from five to fifty in different species. The stems are also jointed and at each node some species produce a whorl of branches which may be simple or compound. Some species however like the common scouring-rush (E. hiemale) usually produce simple stems.

- 98. The leaves are produced also at the nodes, and by the union of their margins form a short sheath which ends in a row of teeth. These teeth may be deciduous or persistent and their number, varying from three upwards, indicates the number of leaves forming the united whorl.
- 99. Stomata (86) are distributed along the valleculæ either irregularly or disposed in ranges on either side of the valleculæ. The epidermis frequently contains much silica and the roughened tubercles of some species give the surface a harsh feeling.
- roo. Fructification.—The fructification in Equisetum is arranged in cone-like spikes borne at the apex of the fertile stems. These spikes are composed of successive closely-placed whorls of shield-shaped, stalked scales or modified leaves, each of which bears from five to ten one-celled sporangia on its under side. The sporangia open along the inner side to discharge their numerous spores whose outer coat is spirally split into two bands forming the so-called elaters. The elaters when dry are spread out at right angles to each other in the form of a cross and probably assist in scattering the spores; when moist they rapidly absorb water and become closely coiled around the spore.
- powers of germination.—The spores of Equisetum retaining their powers of germination only a few days soon develop branched and irregularly lobed prothallia which are provided with chlorophyll. These are usually diœcious, the male being smaller and producing antheridia at the end or margin of the larger lobes. The antherozoids are large and provided with a peculiar appendage known as the "float." The female prothallium may reach one-half inch in length and develops archegonia on the anterior margin of the fleshy lobes. The process of fertilization is similar to that of ferns.
- existed since the coal period and the genus Equisetum since the Triassic. The order Calamariace which combined characters of modern Equiseta and Conifers came into existence in the Devonian but became extinct before the close of the Permian. Illustrations of Calamites can be seen at the left hand corner of the frontispiece also under the tree-fern in the centre.

C. THE CLUB-MOSSES.

103. General Characters.—The club-mosses are chiefly small perennial plants usually growing in dry or moist woods or even

on exposed rocks with little soil for nourishment. Most of the species are somewhat moss-like in habit as might be suspected from the popular names given to these plants, the genus Lycopodium taking the name of club-moss and Selaginella that of rock-moss. Various species of Lycopodium are also known as ground-pine, ground-fir. ground-cedar. running-pine, etc. from more or less marked resemblances. (Fig. 33). In the curious Selaginella lepidophylla from Arizona the branches of the closely coiled central



stem roll up when dry into ½ natural size. (After Prantl.) a nest-like ball and when moistened expand so as to appear flat or saucer-shaped. As the plant retains this power indefinitely it has sometimes been called "the Resurrection-plant."

a tendency to become erect, and most species send up erect branches which bear the fruit. Most species bear roots at irregular intervals along the under side of the creeping stems, but our solitary species of *Psilotum* is rootless bearing only underground shoots which perform the functions of roots. The leaves are small and unbranched, in some instances resembling appressed scales, in others resembling the acicular leaves of Conifers, and are arranged in four, eight or many ranks. In some species the leaves are of one kind while in others two or even more forms may occur on the same plant. In *Psilotum* the leaves are all rudimentary.

105. Fructification.—The fructification of the club-mosses is chiefly borne in solitary or clustered (2-5) spikes which are formed of numerous scales or scale-like leaves each bearing a single large

sporangium in its axil. The sporangia open transversely and are one-celled except in *Psilotum* where they are three-celled. In a few species of *Lycopodium* the sporangia are borne near the summit of the fertile stems in the axils of ordinary leaves. The usual shape of the fruit bearing scales is represented in Fig. 34–36.

and Psilotum are of one kind (Fig. 34) but in Selaginella two kinds of sporangia are developed, the microsporangia producing numerous microspores (Fig. 35) not unlike the spores of Lycopodium, and the macrosporangia producing usually four macrospores (Fig. 36) so called from their larger size. This character of Selaginella which it shares with the quill-worts and pepper-worts soon to be described, serves as the basis for the

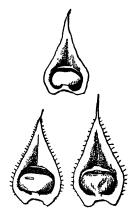


Fig. 34. Scale of spike of Lycopodium Carolinianum, L., bearing a sporangium in its axil.

Fig. 35-6. Scales from fertile spike of Selaginella rupests is, Spring disclosing two sorts of spores. (After Sprague.)

division of the fern-allies into two groups: the *isosporous* producing spores of one kind; and the *heterosporous* producing spores of more than one kind.*

seen and fully studied in only one species, L annotinum \dagger , in which the prothallium grows underground, is destitute of chlorophyll, irregularly lobed and sparingly furnished with root-hairs. The antheridia and archegonia are borne in grooves on the upper side. In the method of reproduction this Lycopodium bears a resemblance to the OphioglossaceE.

108. In Selaginella the contents of the ripened microspores are transformed into a mass of tissue consisting of a few cells, one of which remains sterile and is considered a rudimentary prothallium, while the others give rise to antherozoids and are consequently considered as a rudimentary antheridium. The macrospores on the other hand produce a many-celled prothallium which develop a few root-hairs and numerous archegonia

^{*} This division though used by some of the best botanists is at best an artificial classification as it separates genera otherwise closely allied to each other.

[†] J. Fankhouser, 1872. Described in Botanische Zeitung, 1873, pp. 1-6.

which, after fertilization, give rise to a new plant. Two plants are sometimes produced on the same prothallium.

- Tog. The microspores are thus seen to be male and the macrospores female, showing a clearer differentiation of sex in the products of the mature plant than appears in any other group of the fern-allies already studied. This may be considered a foreshadowing of the completely differentiated sexual organs which occur in the Phanerogamia. In the method of formation of the embryo the Selaginella also differs from all other Cryptogamia and approaches the flowering plants.
- DEACE and SIGILLARIACE were very abundant in the Palæozoic era, particularly during the Carboniferous where they formed the largest part of the forest vegetation reaching in some instances a height of seventy to one-hundred feet! The former possessed characters connecting modern club-mosses with Conifers while the latter seem to connect the club-mosses with the Cycads.* Restorations of Lepidodendron may be seen on the left hand side of the frontispiece and of Sigillaria on the right.

D. THE QUILLWORTS.

- appearance of the leaves, are principally inconspicuous aquatic plants of a grass-like or rush-like aspect (Fig 37). Some species are always submerged often in several feet of water, others grow in marshy soil or in the shallow margins of ponds where they become apparently terrestrial in time of low water, while others still are found between high and low water marks where they will be covered by water at high tide. The leaves are awl-shaped or linear and are attached to a short fleshy trunk. They vary in number from ten to one hundred in each plant, and in length from two to twenty inches in various species.
- 112. Fructification.—The sporangia of the quillworts like those of the club-mosses are sessile in the base of the leaves. The leaf base sometimes called the sheath is somewhat triangular from a broad insertion, convex behind and concave in front where there is a large depression known as the *fovea* which contains

^{*} Some palæobotanists regard Sigillaria as a Cycad with strong Lycopod affinities.

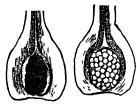


Fig. 38-9. Two kinds of sporangia in I. lacustris, L., enlarged. (After Sprague.)

the sporangium. The margin of the fovea rises in the form of a delicate membrane called the velum, which in many species lies above the sporangium and encloses it. The sporangia of the outer leaves contain large spherical macrospores, those of the inner, numerous, oblong, triangular microspores. The size and marking of the spores form important characters in distinguishing species. (Fig. 38-9.)

113. Germination.—The microspore after remaining dormant through the winter forms a few-celled structure which produces the antherozoids which are long and slender and provided with a tuft of cilia at each end. The macrospore produces a prothallium much as in Selaginella (108);

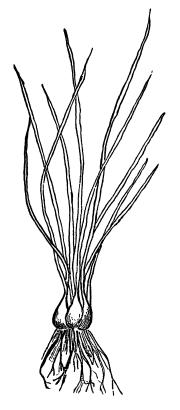


Fig. 37. Isoetes lucustris, L., natural size. (Original.)

from this the germ of the mature plant arises after fertilization by the antherozoids.

114. Geologic Distribution.—Two species of *Isoetes* have been found in the Miocene (Tertiary). No nearer allies are known than those mentioned in 110.

E. THE PEPPERWORTS.

115.—General Characters.—The pepperworts, so called from the shape of the fruit in some genera, include aquatic plants of very diverse characters. Some like *Marsilia* root in mud and produce long-petioled leaves resembling "four leaf clovers," which float on the surface of water. Others like *Azolla* are little floating plants much resembling a liverwort. *Marsilia* and *Pilularia* have a circinate vernation and have therefore received the name

of "water ferns." Marsilia quadrifolia (Fig. 40) is found on the shores of Bantam Lake, Litchfield Co., Ct.* where it literally covers the margin of the lake for two miles or more.

The fruit of Marsilia consists of a hollow stalked receptacle known as the sporocarp which bears the sporangia in sori on the inner walls of its two valves. The spores are of two kinds as in this entire group of plants.

II7. Germination.—In Marsilia the antherozoids are produced in the microspore itself and are corkscrew-shaped, consisting of several coils. The prothallium, developed from the apex of the macrospore, is a hemispherical mass of tissue and contains a single archegonium.

118. Geologic Distribution.—Four genera are found fossil extending from the Jurassic. *Marsilia* and *Pilularia* occur in the Tertiary.

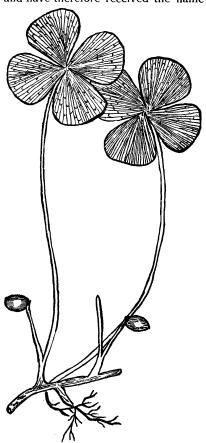


Fig. 40. Marsilia quadrifolia, L. Natural size though the petioles are frequently three times as long. (Original.)

^{*} This species was first discovered in America by Dr. T. F. Allen some twenty-five years ago in Bantam Lake and is now rapidly increasing. It is probably an emigrant from some distant locality but the method of its introduction is a mystery.

CHAPTER VII

CLASSIFICATION AND NOMENCLATURE OF FERNS AND THEIR ALLIES

The education of a naturalist now consists chiefly in learning how to compare.

---Agassi

119. Nomenclature.—Before the time of Linnæus, the method of naming plants and animals was a subject of much embarrassment to science and gave rise to endless confusion. This great author, justly called the "Father of Botany," introduced a new system of nomenclature that gave a new impetus to the study of nature. His system has since been in constant use and has made possible the greater accuracy and definiteness in the scientific descriptions of subsequent naturalists. He also introduced a system of classification which, though artificial and since abandoned. paved the way to the more natural system since adopted. He arranged the various plants and animals known to him in a few groups according to some particular plan of structure, divided these into still smaller groups and so on to the lowest divisions. genera and species. To these divisions special names were assigned, thus giving to each organism a double name, the first generic which may be likened to our family name, the other specific corresponding to our baptismal name. Thus the common marginal shield-fern bears the appellation Aspidium marginale given it by the Swedish botanist. Olaf Swartz. The first it bears in common with all the shield-ferns which have a like method of fructification. The latter is peculiar to this particular species which bears its sori near the margin of the segment.

120. Generic Names.—These may be derived from some characteristic of growth or structure, in honor of some botanist or distinguished patron of science, or occasionally from some mythological or symbolical character.

121. Specific Names.—These are usually adjective elements either Latin or Latinized and must agree in gender with the generic name according to the rules of Latin syntax. Errors in agreement have frequently been made by botanists who were not versed in the classics, and it is unfortunate that errors of this character as well as gross errors in the orthography of generic names have found their way into accepted text-books of botany.* Specific

^{*}Cistopteris for Cystopteris is an example.

names frequently indicate something regarding habit or mode of growth or may indicate the locality in which the organism was first discovered. A few take their name from their discoverer, in which case the name is Latinized and takes a genitive ending.

- 122. The advantage of this binary nomenclature is at once evident when we consider the immense number of ferns alone, to say nothing of the remainder of the vegetable world and the hosts of the animal creation. By this means organisms of complex structure can be definitely characterized with comparatively few words and the scientific name once established remains the same among scientists of all nations and languages.
- 123. There are, however, liabilities to error and confusion in the Linnæan system of nomenclature, as various authors have often assigned the same name to several species. For example, the name *Cheilanthes vestita* was given by Brackenridge to Eaton's *C. gracillima*. Hooker assigned the same name (in part) to Nuttall's *C. lanuginosa*, while Swartz assigned the same to the fern described in this volume under the name of *C. vestita*. It becomes necessary, therefore, in referring to a species to indicate the author of the specific name usually, if written, by an abbreviation.
- 124. Synonymy.—It may also be remarked in this connection that different authors have described the same fern under widely different generic and specific names. For example, the delicate Woodsia Ilvensis of Brown was described as Acrostichum Ilvense by Linnæus, Polypodium Ilvense by Swartz, Nephrodium rufidulum by Michaux, Aspidium rufidulum by Willdenow and Woodsia rufidula by Beck. Many other species have been as variously classified. From the confusion of the past we are rapidly emerging and our nomenclature is coming to be established on a permanent and scientific basis.
- r25. Species.—Goethe tells us that nature knows only individuals, and that species exist only in the school-books. From this extreme there has been every grade of opinion respecting species to the direct opposite which regards species as invariable, actual existences, types originally ordained and summoned to existence by the Creator. Linnæus, for example, defined species in these words: "Species tot sunt diversæ, quot diversas formas ab initio, creavit infinitum ens."* Various definitions have been given to species, but none accord with the actual practice of systematists who seem inclined to make a species what they choose, and, in-

^{*} There are as many different species as the Infinite Being created in the beginning

deed, the existence of various connecting forms between many species distinct under normal conditions, makes the practical definition of the term almost an impossibility. We may, however, for practical purposes, regard as a species an assemblage of individuals not differing essentially from each other, and capable of producing like individuals by the ordinary processes of reproduction. A recent writer defines species as "the present aspect of a line of organic development, destined to become something else in the future, as it was something else in the past."* This would seem to be in accordance with the now widely accepted biological doctrine respecting the origin of species. Species among ferns are founded chiefly on differences in the cutting of the fronds and their method of venation.

r26. Varieties.—Many forms differing only slightly from the ordinary specific types, and yet capable of transmitting their variations from generation to generation, are regarded as varieties. It was the opinion of one of our best Cryptogamic botanists that all so-called varieties among Cryptogams "were purely the result of the accident of environment and never of crossfertilization."† Since a species which varies in some minor particular is likely to revert to the ordinary form as soon as the normal conditions of soil, moisture or environment are restored, there is no scientific foundation for the multiplication of varieties to serve as rubbish in works on systematic botany. There is a tendency on the part of a few authors to multiply varieties indefinitely, and of a single species as many as sixty-five varieties have been described. Among the best systematists, however, there is a growing tendency to restrict the number.

127. Genera.—The genera of ferns are founded mostly on the arrangement of the sporangia on the veins, as well as the character, shape, and position of the indusia.

128. Tribes.—Genera are collected into tribes, according as they agree in the position and arrangement of the sporangia in clusters or sori, or resemble each other in mode or habit of growth.

129. Sub-Orders.—Tribes are grouped into sub-orders, according as they agree in the characters of the sporangium, its shape, method of discharging its spores, and the existence, character, or absence of a ring.

130. Orders.—Ferns are often classed in a single order, but in accordance with the latest researches of the best structural botan-

^{*} Dr. A. Winchell in Preadamites, p. 232.

[†] Coe F. Austin, MSS.

ists, they are separated into three distinct orders, FILICES, MARATTIACEÆ and Ophioglossaceæ, which are distinguished by the method in which the sporangia are developed, and also by other minor characteristics. Two of the orders are well represented in our flora. The MARATTIACEÆ are mostly confined to tropical regions. The horsetails (Equisetum) form a distinct order, the Equisetaeæ. The club-mosses of the genera Lycopodium and Psilotum with two genera not found in America form the order Lycopodiaceæ. Selaginella and Isoeles each form an order which takes its name from the single genus. Marsilia and Pilularia form the Marsiliaceæ while Azolla and Salvinia, the latter not found in our limits, form the order Salviniaceæ.

- 131. Principle of Classification.—The true idea of classification is the grouping together of objects according to essential and fundamental resemblances. Every system is more or less artificial, yet there is a continual approach toward the true natural system, which is the ultimatum of scientific classification. That the various systems of classification as applied to ferns, as well as their position in the vegetable kingdom, may be better understood, the following outlines from a few of the leading botanists are appended.
- 132. Linnæan System. The Cryptogamia or flowerless plants formed class xxiv of the Linnæan system of classification and contained the following orders:—I. Filices (Ferns). II. Equisetacea (Scouring Rushes). III. Lycopodineæ (Club Mosses). IV. Musci (True Mosses). V. Hepaticæ (Liverworts). VI. Algæ (Sea Weeds). VII. Lichenes (Lichens). VIII. Fungi (Mushrooms).*
- 133. Lindley, in his "Vegetable Kingdom," divides the asexual or flowerless plants into two classes, Thallogens and Acrogens, the latter containing eleven families of mosses, ferns and their allies.
- 134. Dr. Asa Gray, in the fifth edition of his "Botanical Text Book," restricted Acrogens so as to include only such flowerless plants as contain woody tissue and vessels, while the mosses and liverworts are placed in a separate class, Anophytes. This distinction, however, has been modified in the last edition by dividing the class Acrogens into Cellular and Vascular.
- 135. Sachs classified the vegetable kingdom into five *Groups* and these are subdivided into thirteen *Classes* as follows:—I.

^{*} Linnæus recognized only four orders: Nos. 11, 111, v and vii have been added by later botanists.

ALGÆ (Confervæ, Seaweeds). II. Fungi (Mildew, Mushrooms, Lichens). III. Characeæ (Chara). IV. Hepaticæ (Liverworts). V. Musci (Mosses). VI. Filices (Ferns). VII. Equisetaceæ (Horsetails). VIII. Ophioglossaceæ (Adder-tongues). IX. Rhizocarpeæ (Hydropterides). X. Lycopodiaceæ (Club Mosses). XI. Gymnospermæ (Conifers, Cycads). XII. Monocotyledonæ (Lilies, Grasses, etc). XIII. Dicotyledonæ (Crowfoots, Roses, Oaks, etc). In this classification the division of the ferns and their allies into classes is not satisfactory and the nomenclature is decidedly unfortunate.

136. Recent Classifications.—A classification more in accordance with recent study will show the relative position of the Ferns and their allies in the vegetable kingdom and at the same time a provisional arrangement of that vast multitude of organisms that are lower than the Ferns in structure and method of reproduction. The schedule is taken from the American edition of McNab's Botany with slight modifications. The seven divisions or subkingdoms are as follows:

I. PROTOPHYTA. SEXLESS PLANTS.

Class I.—Cyanophyceæ (Nostoc. etc.) Class II.—Chlorophyllophyceæ. Class III.—Schizomycetes (Bacteria, etc.) Class IV.—Saccharomycetes (Yeast-plant).

II. ZYGOSPORA.* Uni-sexual Plants

Class I.—ZOOSPOREÆ_(Confervæ, some Algæ, etc.) Class II.—MYXOMYCETES (Slime-moulds). Class III.—Conjugatæ (Diatoms, Desmids, etc.). Class IV.—MUCORINI (Common moulds).

III. OOSPORA.* EGG-SPORE PLANTS.

Class I.—Cœnobieæ (Volvox, etc.) Class II.—Sphærople-Aceæ. Class III.—Cœloblasteæ (Some parasitic Algæ and Fungi). Class IV.—Œdogoniaceæ. Class V.—Fucaceæ (Fucoids, Brown Algæ).

IV. CARPOSPORA.*

Class I.—Coleochæteæ. Class II.—Florideæ (Red Algæ).

^{*}A uniform terminology is a desideratum in botanical science, and has been much neglected apparently by many systematists. Instead of Zygosforre I have written Zygosforre for sake of uniformity and would suggest a similar chauge in the terminology of some of the classes. The ending accee, has long been reserved for botanical orders, and for the sake of uniformity all groups of plants receiving ordinal rank, should receive this termination. Selaginellee may thus be more properly written Selaginellaee. In a recent text-book the old original name Lycopodiaee is changed to Lycopodiae without obvious reason. Were the term Filices not so long established it could with profit be changed so as to conform with the termination of the other PTERIDOPHYTA.

Class III.—CHARACEÆ (Chara, etc.) Class IV.—ASCOMYCETES (Mildews, Truffles, Lichens). (The Uredineæ, and the Ustilagineæ, the former containing rust, etc., and the latter containing smut, etc. are not well-known but probably rank here). Class V.—Basidiomycetes (Mushrooms, Toadstools).

V. BRYOPHYTA.

Class I.—Hepaticæ (Liverworts). Class II.—Musci (True Mosses).

VI. PTERIDOPHYTA. Ferns and their Allies.

VII. PHANEROGAMIA. FLOWERING PLANTS.

137. Classification of the Pteridophyta.—In the systematic part of the present volume the PTERIDOPHYTA or Vascular Cryptogams are arranged in the following order:

CLASS I.—EQUISETINÆ.

Order 1.—CALAMARIACEÆ. (Extinct).

Order 2.—Equisetaceæ. Including Equisetum.

CLASS II.—FILICINÆ,

* Vernation erect or inclined.

Order 3.—OPHIOGLOSSACEÆ. Including Ophioglossum,

Botrychium, etc.

** Vernation circinate.

Order 4.—MARATTIACEÆ. Including four tropical genera.

Order 5.—FILICES. Including 70 genera of ferns.* CLASS III.—RHIZOCARPEÆ.

Order 6.—MARSILIACEÆ. Including Marsilia and Pilu-

Order 7.—Salviniaceæ. Including Azolla, etc. Class IV.—LYCOPODINÆ.

* Isosporous.

Order 8.—Lycopodiace. Including Lycopodium,

Psilotum, etc.

** Heterosporous.

Order 9.—LEPIDODENDRACEÆ. (Extinct).

Order 10. SIGILLARIACEÆ. (Extinct).

Order 11.—Selaginellaceæ. Including Selaginella.

Order 12.—ISOETACEÆ. Including Isoetes.

^{*}This number is based on Hooker's classification. Other authors, narrowing the limits of generic characters, recognize a greater number. Smith, for example, publishes 220, and Preel 230, yet the tendency among most botanists is to restrict the number

CHAPTER VIII

HOW TO STUDY THE PTERIDOPHYTA

The great benefit which a scientific education bestows, whether as training or as knowledge, is dependent upon the extent to which the student * * learns the habit of appealing directly to Nature.—Huxley.

a plant or animal is not its name, but its structural characteristics, knowing which the name can be readily determined. Having provided ourselves with a strong lens, two or more needles mounted in wooden handles for dissecting purposes, and a few well fruited ferns taken with the roots, we are prepared to commence our study. In investigating any plant we should be systematic and accurate in our observations, and no subject will develop order and accuracy of description or enlarge our powers of observation as will the subject of botany rigidly pursued. In order to fix the characters of the fern in question, it is well to note them down in some systematic order, and the preparation of blanks like the following is suggested for the purpose:

Synoptical characters of				
ROOT.				
ROOTSTOCK.				
STIPE.				
FROND.				
VEINS.				
SORI.				
SPORANGIA.				
SPORES.				

The characters thus commence with the lowest parts and continually advance upwards to completion.

139. Taking now a common fern we will notice its characteristics. Suppose it to be the one commonly called "Maidenhair" in the Northern States. We take the parts in order and give them a searching examination: the character of the root; the direction of growth, position and appearance of the rootstock; the appearance, color and method of growth of the stipe; the method of cutting of the frond and the character of its surface; the method of veining; the position of the fruit clusters on the frond and veins, and the peculiar form of the indusium, if present. The sporangia and spores are best studied with a microscope, yet the shape of the sporangia and the character of the ring can be determined with a strong lens.

140. The characters of the Maidenhair can be summed up as follows:

Synoptical characters of			
Adiantum pedatum, L.			
ROOT.	Many delicate fibres, somewhat matted.		
ROOTSTOCK.	Scaly, somewhat creeping.		
STIPE.	Separate, slender, polished, black, forked at base of frond forming two recurved rachises.		
FROND.	Roundish in outline, formed of several pinnæ, which branch from the recurved rachises; pinnules unequal sided, oblong or deltoid; upper margins irregularly lobed; surfaces smooth.		
VEINS.	Free, several times forked.		
SORI.	Borne at the end of the veins on the under side of the re- flexed margins of the lobes which form somewhat kidney- shaped membranous indusia.		
SPORANGIA.	Globose with a nearly complete vertical ring.		
SPORES.	Minute, of one kind.		

141. We are now prepared to determine the specific name, and for this purpose will turn to the "ARTIFICIAL SYNOPSIS OF ORDERS," where we read the statements under A with the first of which our plant agrees, then to B as directed where we find it agrees with the third statement, then to C we determine the Order

to which our plant belongs. After having determined the plant to be a member of the order FILICES we proceed to the "ARTI-FICIAL SYNOPSIS OF GENERA." Reading the two statements under A we find our plant agrees with the first, bearing the sporangia at the margin of a leafy frond, so we proceed to B as indicated at the right hand margin. There being an indusium present, we are directed to C, where we find four statements. Our fern agrees with the second, as the indusium is formed of a reflexed portion of the frond. Passing to D we find it agreeing with the first statement. Passing to E the statement, "Sporangia at the ends of the veins, borne on a reflexed portion of the margin of the frond," answers our purpose, and the marginal reference indicates the genus Adiantum. Under this genus we find two statements design nated by *, and **; the latter referring to the "dichotomously forked" fronds, answers our purpose, and we find our fern to be number 5, Adiantum pedatum, L., the scientific name of the Maidenhair, which we can now place in our description. Were we in Florida or any of the Southern States, instead of A. pedatum we would probably have found the Venus' Hair (A. Capillus-Veneris), or in California the Californian Maidenhair (A. emarginatum) either of which would agree with the common Eastern species in all respects save the method of branching of the frond and the shape of the pinnules. In like manner we can trace any of our native species to their scientific names, by carefully noting their structure and methods of fruiting.

142. In a few ferns it will be necessary to exercise great care in the examination of the indusia. In the genera *Cystopteris*, *Dicksonia* and *Woodsia*, and in a few species of *Aspidium* the indusia wither away after fruiting, so that one is likely to classify them under the non-indusiate genera if he carelessly examines them in this condition. In such cases a large number of sori should be carefully examined and the least trace of an indusium should be noted. Five-sixths of our genera, including four-fifths of our species, are indusiate.

143. Fern Allies.—In determining the species of the fernallies the method of procedure is quite similar to that indicated above for the Maidenhair, in each case referring the plant to its proper order. The specimens must be in fruit and in the case of *Equisetum* must include both sterile and fertile shoots. As the species of *Isoetes* differ mainly in the size, character and markings of the spores they will require a microscope for successful determination.

- 144. Histology.—The minute structure of the ferns will furnish unlimited opportunity for observation with the highest magnifying powers of the compound microscope. Sections for examination should be shaved very thin with a razor or with knives made for the purpose, so as to be transparent, otherwise they must be illuminated from above by a condenser or stage mirror. In this way sections of stipes, foliage, epidermis or sori can be examined to advantage, illustrating the various forms of tissue. The scales, hairs, tomentum and glands of various species will also furnish interesting material for study. The sporangia are small enough to be examined entire and can be viewed at different stages of growth. The annulus or ring can be seen in all its positions and the method of bursting determined. The spores form an interesting subject for investigation, and require the highest powers for successful observation. Practice only will develop methods of observing that cannot be easily placed in the form of suggestions. The interest will become deeper at every step, and the subject of determination of species or study of the more apparent characters, is incomparable with the subject of microscopic investigation in inspiring wonder or stimulating the mental powers.
- 145. Germination.—The germination of the fern spores can be studied by sowing fresh spores on a glass slide and keeping them moist and warm; they can be kept to advantage under a glass dome and taken out at intervals and examined. The examination of the sexual organs will require skillful manipulation and enduring patience, but the success attained by careful toil will prove an abundant reward.

CHAPTER IX

LITERATURE OF THE PTERIDOPHYTA

Of making many books there is no end.—Solomon.

A. AMERICAN.

- Beck (Lewis C.) Synoptical Table of the Ferns and Mosses of the U. S. In Silliman's Journal, Vol. IV, 1829. Catalogue of 88 PTERIDOPHYTA including 63 ferns.*
- Bigelow (Jacob). Florula Bostoniensis, 3rd Ed. 1840. Descriptions of 43 PTERIDOPHYTA including 30 ferns.
- Braun (Alexander). A Monography of the North American species of the genus *Equisetum*. With additions by George Engelmann, M. D. In Silliman's Journal, Vol. XLVI, 1843. Describes the then known N. A. species of *Equisetum*.
- On the N. A. species of *Isoetes* and *Marsilea*. Communicated by Dr. G. Engelmann. In Silliman's Journal, Second Series, Vol. III. 1847. Descriptions of five species of *Isoetes* and three of *Marsilia*.
- Britton (N. L.) Preliminary Catalogue of Flora of New Jersey, 1881. List of 57 PTERIDOPHYTA including 39 ferns.
- Chapman (A. W.) Flora of the Southern States, 1860. Descriptions of 14 species of PTERIDOPHYTA (exclusive of ferns).
- Coulter (John M.) and Barnes (Charles R.) Catalogue of the Plants of Indiana, 1881. List of 43 PTERIDOPHYTA including 34 ferns.
- Curtiss (Moses A.) Geol. and Nat. Hist. Survey of North Carolina, Part III, Raleigh, 1867. List of 37 ferns.
- Davenport (George E.) Notes on *Botrychium simplex*, 4to. paper, illustrated, 1877. Containing valuable notes on this variable species and its allies.
- Vernation in Botrychia. In Torrey Bulletin, Jan. 1878, illustrated. Also additional notes, Nov. 1880 and Sept. 1881.
- ——— Aspidium spinulosum (Swartz) and its varieties. In American Naturalist, Nov. 1878.
- —— Catalogue of the "Davenport Herbarium" of North American Ferns, Salem, 1879. List of 141 species and 16 varieties of ferns with notes on distribution, etc.

^{*} Including orders Filices and Ophioglossace as elsewhere in this chapter unless otherwise stated.

- ---- New Species of Ferns. In Torrey Bulletin, Dec. 1877, May 1880, June 1881.
- Fern Notes. In Torrey Bulletin Aug. 1880, Aug. 1881, Feb. 1882.
- Onoclea sensibilis, var. obtusilobata. In Torrey Bulletin, Oct. 1881.
- Eaton (Daniel C.) Ferns of the Mexican Boundary. In Mexican Boundary Survey, 1857. List of 44 PTERIDOPHYTA with descriptions of new species.
- Ferns of the Southern States. In Chapman's Flora of the Southern States, 1860. Describes 56 species.
- —— Ferns of Northern United States. In Gray's Manual, 5th Edition, 1868. Describes 57 species.
- Notes on some of the Plants in the Herbaria of Linne and Michaux. In Canadian Naturalist, Mar. 1870. Contains interesting notes on species collected or named by these early botanists.
- —— Ferns of the 40th Parallel. In King's Geological Report, Vol. V, 1871. List of 19 Ртелиорнута.
- New and Little Known Ferns of the United States. In Torrey Bulletin, Mar. 1873, May 1873, May 1875, Jan. 1876,
 Oct. 1878, Apr. 1879, Nov. 1879, June 1880, Jan. 1881, Sept. 1881,
 Apr. 1882. Valuable notes and descriptions of new species.
- —— Ferns of North America. Illustrated with colored plates drawn by J. H. Emerton and C. E. Faxon. This finely executed work contains descriptions of the North American species miscellaneously arranged; it contains also a systematic arrangement with brief synoptical descriptions. It was originally published in parts, and though somewhat expensive, ought to be in the library of every lover of the subject. The reputation of its author is a sufficient recommendation.
- —— Ferns of the South West. In Wheeler's Geological Reports, Vol. VI, 1877. Describes 72 species.
- Vascular Acrogens of California. In Botany of California,
 Vol. II, 1880. Describes 56 PTERIDOPHYTA including 43 ferns.
 Systematic Fern List. Sept. 1880. Includes 151 species
- ——— Systematic Fern List, Sept. 1880. Includes 151 species and 17 varieties.
- Edwards (William). Catalogue of North American Ferns, 4th Edition, 1876. Check-list of 133 species and 20 varieties.
- Engelmann (George). New species of *Marsilia*. In Silliman's Journal, Second Series, Vol. VI, 1848. Descriptions of two species.

- ——— Isoetes of Northern U. S. In Gray's Manual, 5th Edition, 1868. Describes 7 species.
- —— The species of *Isoetes* of the Indian Territory. In Bot. Gazette, Jan. 1878. Description of *I. Butleri*, n. sp.
- -— The genus *Isoetes* in North America. In Trans. St. Louis Acad. Sci. Vol. IV, No. 2, 1882. A valuable monograph of this most difficult genus of the PTERIDOPHYTA.
- Flint (William F.) Catalogue of Plants of New Hampshire. In Geol. New Hampshire, Vol. I, 1874. Includes list of 39 ferns.
- Frost (Charles C.) List of Vermont Equisetace and Filices. In Trans. Orleans Co. Soc. Nat. Hist., 1871.
- Gray (Asa). On the Discovery of two species of *Trichomanes* in the State of Alabama. In Silliman's Journal, Second Series, Vol. XV, 1853. Description of *T. Petersii*, n. sp.
- —— Vascular Acrogens of Northern U. S. In Manual of Botany, 5th Ed., 1868. Describes 26 species (excluding *Isoetes* and FILICES).
- Harvey (F. L.) Ferns of Arkansas. In Bot. Gazette, March and May 1881. List of 38 species.
- Jones (Marcus E.) The Ferns of the West. In Utah Review, commencing Oct. 1881. Includes very brief synoptical descriptions of the species of the far West.
- Kunze (G.) Notes on some Ferns of the U.S. In Silliman's Journal, Second Series, Vol. VI, 1848. Communicated by G. Engelmann. Contains notes on several American ferns and their allies with descriptions of several species.
- Lemmon (J. G.) Ferns of the Pacific Coast (including Arizona), 1882. A catalogue of 73 species with their distribution, and a Synopsis of Tribes and Genera.
 - Woodsia Plummeræ, n. sp. In Bot. Gazette, Jan. 1882.
- Leonard (W. H.) Filical Flora of Minnesota. In Bull. Minn. Acad. of Nat. Sci., 1877. Enumerates 30 species.
- Mann (B. Pickman). List of Vascular Cryptogams of N. A. In Catalogue of Plants east of Mississippi River, 2d Edition, 1872. Enumerates 173 species including 123 species and 10 varieties of ferns.
- Parry (C. C.) Catalogue of Plants of Wisconsin and Minnesota, 1848. In Owen's Geol. Survey of Wis., Iowa and Minn. Includes list of 38 species of PTERIDOPHYTA.
- Patterson (Harry N.) Catalogue of Illinois Plants, 1876. Enumerates 50 species of Pteridophyta including 36 ferns.
- Porter (Thomas C.) and Coulter (John M.) Synopsis of the Flora

- of Colorado, 1874. List of 27 PTERIDOPHYTA including 21 ferns with descriptions of several species.
- Portland Soc. of Nat. Science. Catalogue of Maine Plants, 1868. With the additions by Frank A. Mansfield, 1881, including list of 43 Pteridophyta, 29 ferns.
- Redfield (John H.) Geographical Distribution of the Ferns of North America. In Torrey Bulletin, Jan. 1875.
- Robinson (John). Check-list of the Ferns of North America, 1873. List of 126 species and 12 varieties.
- ——— Ferns of Essex Co., Mass. In Bull. Essex Inst., Mar. 1875, with Addenda, Oct. 1875. List of 46 Pteridophyta found in that county.
- Ferns in Their Homes and Ours. 12mo., illustrated, 1878. A valuable outline of fern cultivation, indispensable to those desiring to undertake the cultivation of ferns either in conservatories or Wardian cases.
- Rust (Mary O.) Filices Onondagenses, Apr. 1879. A list of ferns of Onondaga Co., N. Y., including 40 species.
- ——— Pursh's Station for *Scolopendrium* Rediscovered. In Torrey Bulletin, Sept. 1879.
- Torrey (John). Flora of New York, 1843. Descriptions of 57 species of Pteridophyta including 41 ferns.
- Report of the Botanical Collections made on the Pacific R. R. Surveys, 1857. Enumerates 26 species of PTERIDOPHYTA.
- Torrey Bulletin. Ferns of New York, Oct. 1878. List of 50 species. July 1881, addition of two species by L. M. Underwood.
- Tuckerman (Edward) and Frost (Charles C.) Catalogue of Plants growing within 30 miles of Amherst College, 1875. Contains list of 43 ferns.
- Underwood (Lucien M.) List of North American PTERIDOPHYTA (excluding Orders Filices and Ophioglossaceæ), 1881. Including 52 species.
- —— Our Native Ferns and How to Study Them, with Synoptical Descriptions of the North American species, 12mo. 1881.
- Onoclea sensibilis, var. obtusilobata. In Torrey Bulletin, Sept. 1881.
- Watt (D. A. P.) The Acrogens of Lake Superior. In Canadian Naturalist. Enumerates 60 PTERIDOPHYTA including 37 ferns.
- Wheeler (Charles F.) and Smith (Erwin F.) Catalogue of Michigan Plants, 1881. Includes list of 66 Pteridophyta including 47 ferns known to grow in the state.
- Williamson (John), Ferns of Kentucky, 12mo, 1878. Illustrated

by the author with Etchings of the ferns of that state 40 in number.

—— Fern Etchings, 12mo. 1879. Containing descriptions and etchings of the ferns of Northeastern United States and Canada. Wood (Alphonso). Class Book of Botany, 1869. Describes 84 species of Pteridophyta including 57 ferns.

In addition to the above list, short and more or less valuable notes on various species of ferns and their distribution may be found in the following journals: Torrey Bulletin, Vol. II, pp. 24, 28. Vol. III, pp. 2, 33. Vol. IV, pp. 2, 16, 42. Vol. V, pp. 38, 39. Vol. VI, pp. 8, 175, 177, 199, 206, 221, 234, 291, 348. Vol. VII, pp. 16, 80, 89, 94, 96, 118. Vol. VIII, pp. 47, 105. BOTANICAL GAZETTE, Vol. VI, pp. 195, 220. It is almost unnecessary to add that these two journals have become a necessity to American botanists.

The only strictly American work on structural botany that treats of fern structure is the recently issued botany by Prof. C. E. Bessey, published by Henry Holt & Co. It devotes twenty-eight of six hundred pages to the subject of the PTERIDOPHYTA. It is a valuable introduction to the study of structural botany.

B. FOREIGN.

The following list includes a few of the more important foreign publications which contain descriptions or plates of American Pteridophyta or that treat of the general structure or classification of this group of plants.

- Berkeley (M. G.) Introduction to Cryptogamic Botany.
- Cooke (M. C.) A Fern Book for Everybody. London, 1868. Classifies the British ferns.
- Fee (F. L. A.) Memoires sur la Famille des Fougeres. Strasburg, 1844—1873.
- ——— Catalogue des Fougeres et des Lycopodiacees du Mexique. Strasburg, 1857.
- Histoire des Fougeres et des Lycopodiacees des Antilles. Strasburg, 1866.
- Hooker (William Jackson). Genera Filicum. London, 1842. Illustrated by magnificent plates representing 135 genera and sub-genera.
- —— Species Filicum. 5 vols. London, 1846—1864. Contains nineteen plates of American ferns.
- Hooker (W. J.) and Baker (John Gilbert). Synopsis Filicum. 2d Ed., London, 1874. Contains descriptions of all ferns known

at that date, and is valuable for the determination of species from beyond our limits. It lacks one very essential feature of a systematic work, namely, a key to the genera, and the grouping of the species is such as to make it often difficult to identify them.

- Hooker (W. J.) and Greville (Robert Kane). Icones Filicum. 2 vols. London, 1831. Plates of thirteen American ferns.
- Lowe (E. J.) Ferns British and Exotic. 8 vols. London, 1867. Contains colored plates of many American ferns. The text is not very reliable.
- ——— New and Rare Ferns. London, 1868. Properly the ninth volume of the above series.
- Milde (J.) Monographia Equisetorum. Dresden, 1865.
- Sachs (Julius). Lehrbuch der Botanik. (Translated into English by A. W. Bennett. Oxford, 1875.) Without doubt the best work yet published on the subject of botanical morphologyphysiology, and the principles of classification.
- Smith (John). Historia Filicum. London, 1875. Contains a review of the classification of various authors and a statement of the author's system.
- Ferns British and Foreign. London, 1879. Includes a treatise on cultivation.
- **Spring** (A.) Monographie de la Famille des Lycopodiacees. Bruxelles, 1842 et 1849.
- Swartz (Olaf). Synopsis Filicum. Kiliæ, 1806.

OUR NATIVE PTERIDOPHYTA

I love not man the less, but Nature more, From these our interviews, in which I steal From all I may be, or have been before, To mingle with the Universe, and feel What I can ne'er express, yet cannot all conceal.

-Byron

PTERIDOPHYTA. Cohn.

Vascular acrogens containing woody tissue in the stems. Antheridia or archegonia or both formed on a prothallus which is developed from the spore on germination, and upon which the asexual plant is produced. Includes eight living and three extinct orders, all represented in North America.

ARTIFICIAL SYNOPSIS OF ORDERS.

	mericane stroisis of orders.	
A	{ Isosporus, i. e. spores of one kind	B D
В	Plant rush-like Order I. EQUISETACEÆ. Plant moss-like Order VI. LYCOPODIACEÆ. Plant fern-like	С
С	Vernation erect or inclined; sporangia not reticulated, in spikes or panicles, opening by a transverse slit. Order II. Ophioglossaceæ. Vernation circinate; sporangia reticulated, provided with a ring, usually borne on the back or margin of a frond sometimes in spikes or panicles Order III. FILICES.	
D E	Terrestrial, moss-like plants	E
	C C C C C C C C C C C C C C C C C C C	

ORDER I. EQUISETACEÆ, DC.

Rush-like plants, often branched, with jointed, usually hollow stems rising from subterranean rootstocks, the sterile leaves reduced to sheaths at the joints, the fertile forming a short spike terminating the stem. Prothallium above ground, green, variously lobed, usually dicecious. Represented at present by only one genus.

I. EQUISETUM, L. HORSE-TAIL. SCOURING-RUSH.

Perennial plants with extensively creeping rootstocks. Stems simple or branched, furrowed lengthwise, hollow, and provided with an outer circle of smaller cavities opposite the furrows as well

as a second and smaller series opposite the ridges. Sporangia adhering to the under side of the shield-shaped scales of the spike, one-celled, opening down the inner side. Spores furnished with two slender filaments attached by the middle. Name from Lat. equus, horse, and seta, a bristle. Contains about 25 species widely distributed.

§ 1. Stems annual, stomata scattered.

* Stems of two kinds, the pale or brownish fertile stems appearing earlier than the herbaceous sterile ones; fruiting in spring.

† Fertile stems simple, soon withering.

- L. arvense, L. (HORSETAIL). Sterile stems green, rather slender, 1°—2° high, 6—19 furrowed; branches numerous, long, mostly simple, 4-angled, minutely roughened, lowest joint commonly longer than the sheath of the stem; fertile stems 4′—10′ high, light brown, the loose scarious sheath mostly distant, whitish, ending in about 12 brown acuminate teeth; spike rarely over 1′ long. (E. boreale, Bong) Va. to Calland northward to Greenland.
- 2. E. Telmateia, Ehrh. Sterile stems ivory white or greenish, stout, 2°—6° high, 20—40 furrowed; branches very numerous, erect-spreading, simple, 4—5-angled, the ridges rough and sulcate, the lowest joint shorter than the sheath of the stem; fertile stems 10′—15′ high, white, many furrowed, the loose brownish sheaths elongated, deeply 20—30 toothed. (E. fluviatile, Sm., E. eburneum, Schreb.) Cal., Ore. and northward.

†† Fertile stems when older producing herbaceous branches, only the naked apex withering.

- 3. E. pratense, Ehrh. Sterile and finally the fertile stems producing straight, simple branches; sheaths of the stem with about 11 short, ovate-lanceolate teeth, those of the branches 3-toothed. (E. umbrosum, Willd., E. triquetrum, Bory., E. Drummondii, Hook.) Mich., Wis. and northward.
- E. sylvaticum, L. Sterile and fertile stems usually 12-furrowed, producing compound branches, the branchlets curved downward; sheaths loose, those of the stem with 8—14 bluntish teeth, those of the branches with 4—5, and of the branchlets 3 divergent teeth. Va. to Mich. and northward to Labrador.
- ** Stems of one kind, herbaceous; branches simple or none; fruiting in summer.

† Sheaths somewhat loose.

5. E. palustre, L. Stems slender, 10'—18' high, very deeply 5—9 grooved, the grooves separated by narrow, wing-like ridges.

roughish; sheaths with about 8 lance-awl-shaped, whitish margined teeth; branches few in a whorl, with mostly 5-toothed sheaths. (*E. pratense*, Reichenb.) Western N. Y. to Wis. and northward.

- 6. E. littorale, Kuhl. Stems slightly roughened, 6—19 grooved, the carinæ convex; sheaths sensibly dilated above, the uppermost bell-shaped; leaves convex, angled beneath, separate at the commisural groove; teeth herbaceous, membranous at the margin, narrow, lanceolate; branches of two kinds, the 4-angled hollow, the 3-angled solid, first joint a little longer or shorter than the sheath of the stem; spores abortive, elaters none. Vt., Canada.

 †† Sheaths appressed.
- 7. B. Limosum, L. Stems 2°—3° high, slightly many-furrowed smooth, usually producing upright branches after fructification; sheaths appressed, with about 18 dark-brown, short, acute, rigid teeth; air cavities wanting under the grooves, small under the ridges. Includes E. fluviatile, L. (E. uliginosum, Muhl., E. Heleckaris, Ehrh.)
- Stems perennial, evergreen; spikes tipped with a rigid point; stomata in regular rows; fruiting in summer.
 - * Stems tall and stout, usually many grooved. † Stems rough, tuberculate; sheaths appressed.
- 8. E. robustum, A. Br. Stems 3°—11° high, and sometimes nearly 1' thick, 20—48 furrowed; ridges roughened with a single series of transversely-oblong, siliceous tubercles; sheath short, cylindric, marked with black girdles at the base, and at the base of the caducous teeth; ridges of the sheaths tricarinate. O. to La., Cal. and northward.
- 9. E. hiemale, L. (Scouring-rush). Stems 1°—4° high, rough, 8—34 furrowed; ridges with two indistinct lines of tubercles; sheaths rather long, cylindric, marked with one or two black girdles; ridges of the sheath obscurely quadricarinate; teeth membranous, soon deciduous. N. Americane allegations and tuberculate.
- 10. **E. lævigatum**, A. Br. Stems 1°—5° high, pale green, 14—30 furrowed; the ridges almost smooth; sheaths elongated, enlarged upward, marked with a black girdle at the base of the mostly deciduous white margined teeth, and rarely also at the base of the sheath; ridges of the sheath with a central carina and sometimes with faint, short, lateral ones. N. C. and O. to La., Cal. and Ore.
- 11. E. ramosissimum, Desf. Stems grooved, more or less roughened, 6—26 furrowed; sheaths dilated, toothed; teeth not

grooved, persistent or deciduous, leaving only a triangular, very rarely a truncated margin; leaves more or less distinct, 3—4 carinate; branches when present, 4—9 angled; series of stomata in I—4 lines; inner bark of ridges higher than the grooves; ridges convex, marked with bands, never with two-rowed tubercles. Cuba. Fla.? Tex.?

** Stems slender, tufted, 5—10 grooved.

- 12. E. variegatum, Schleich. Stems ascending, 6'—18' long, susually simple from a branched base, 5—10 furrowed; sheaths green, variegated with black above, the teeth 5—10, tipped with a deciduous bristle. N. H. to Ill., Col. and northward.
- 13. E. scirpoides, Michx. Stems filiform, very numerous, 3'—6' high, flexuous and curving, mostly 6-furrowed, with acute ridges; sheaths 3-toothed, the bristle tips more persistent; central air-cavity wanting. N. Eng. to Pa., Ill. and northward.

ORDER II. OPHIOGLOSSACEÆ, Lindl.

Vascular Cryptogamia with fronds usually from a fleshy, sometimes bulbous root, straight or inclined in vernation. Sporangia formed of the interior tissue of the frond, spiked or panicled, naked, not reticulated, destitute of a ring, opening by a transverse slit into two valves discharging copious sulphur-colored spores-Prothallium (so far as known) subterranean, not green, monœcious.

- I. Ophioglossum, L. Sporangia cohering in one or more simple spikes. Veins reticulated.
- II. Botrychium, Swz. Sporangia in pinnate or compound spikes or panicles. Veins free.

I. OPHIOGLOSSUM, L. ADDER-TONGUE.

Sporangia large, coriaceous, connate, coherent in two ranks on the edges of a simple spike. Veins anastomosing. Spores copious, sulphur-yellow. Name from Gr. ophis, a serpent, and glossa, a tongue. Includes ten species, four in our limits.

§ I. Euophioglossum. Fertile spike single, arising from the base of the sterile segment.

* Sterile portion near the middle of the stalk.

high, the sterile segment ovate or elliptical-oblong 1½'—4' long, somewhat fleshy, somewhat narrowed at the base, sessile; fertile spike 1' or more long. Me. to Ky., Tenn., Tex., Ariz. III.

** Sterile portion near the base of the stalks.

- 2. O. crotalophoroides, Walt. Rootstock tuberous, 3"-5" thick: stalk 3'-6' high, the sterile segment \(\frac{1}{2}' - \text{1'} \) long, ovate, slightly petioled, the veins somewhat indistinct; fertile spike short and thick, 3"-6" long. (O. bulbosum, Michx., O. vulgatum, var. crotalophoroides, D. C. E.) Fla. to La. VI.
- 3. O nudicaule, Linn. f. Rootstock slightly tuberous; stalk 1'-4' high, the sterile segment $\frac{1}{2}'-1\frac{1}{2}'$ long, ovate or oblong, the veins indistinct; fertile spike linear-acuminate, 6" long, the peduncle very slender. (O. ellipticum, H. and G., O. vulgatum, varnudicaule, D. C. E.) Fla. to Ga. and Cal. VI.
- § 2. CHEIROGLOSSA, Presl. Fertile spikes several, arising from the base of the sterile segment.
- 4. O. palmatum, Plumier. Rootstock fleshy, tuberous, covered with fine wool-like chaff; plant fleshy, 6'-2° high, the sterile segment cuneate at the base, 2-6 lobed or rarely entire, the lobes elongated and tapering; fertile spikes 1-8 or more, borne on the sides of the stipe just below the sterile segment or on its margin. Fla. VI.

II. BOTRYCHIUM, Swz. GRAPE-FERN.

Rootstock very short, erect, with clustered fleshy roots, the bud for the next year's growth usually imbedded in the base of the stipe. Sterile segment of frond pinnately or ternately divided or compound. Fertile segment 1-3 pinnate with double rows of sessile, naked sporangia. Veins free. Spores copious, sulphurvellow. Name from Gr. botrus, a bunch of grapes, alluding to the clustered sporangia. Contains ten species of which seven are found in our limits.

* Vernation wholly straight.

I. B. simplex, Hitch. Plant 2'-7' high, fleshy; sterile segment stalked, very nearly approximate to the rootstock, or even above the middle, ovate, obovate or oblong, entire, incised, or pinnately parted into 1-3 pairs of roundish or semi-lunate lobes; fertile spike long-stalked, simple or 1-2 pinnate: spores the largest of the genus, closely covered with small points; bud smooth; apex of both sterile and fertile segments erect. (Fig. 41). Specimens with the sterile segment composed of two or three pinnately incised divisions form the tion of B. simplex, var. compositum, Lasch. N. Eng., N. Y. and northward, the variety in Wy. T. and Cal. II.



Fig. 41. Verna-

** Vernation partly inclined in one or both portions.

 7^2

* Buds smooth; sterile segments sessile or short-stalked.

2. B. lunaria, Swz. (MOONWORT.) Plant 5'-8' high, fleshy;

sterile segment nearly sessile, borne near the middle of the stalk, oblong, simply pinnate with 5—15 lunate or fan-shaped lobes which are crenate, incised, or entire, close and overlapping, or distant; fertile segment bi—tripinnate, panicled, about the height of the sterile. Apex only of sterile segment bent over and outside of the nearly straight fertile segment in vernation; divisions of sterile frond arranged nearly perpendicularly. (Fig. 42). Ct., N. Y., L. Superior, Col. and British Columbia. II.

3. B. boreale, Milde. Plant 2½'—7' high, smooth, fleshy; sterile segment placed above the middle, sessile, cordate, ovate or deltoid, pinnately parted, acute; lowest segment spreading from a narrower base, ovate or cordate-ovate, acute, all entire, or here and there flabellately incised with acute lobes, or pinnately parted; secondary segments from a narrowed base, ovate, acute, serrate, the upper spreading, quickly decreasing, finally elliptical, acute; fertile segment bi—tripinnate, panicled. Apex of sterile segment bent over inside of the nearly erect fertile one in vernation; divisions of the sterile segment arranged on an angle. Unalaska. II.

B. matricariæfolium, A. Br. Plant 2'
12' high, usually fleshy; sterile segment placed above the middle, short-stalked or sessile, ovate or oblong, pinnately parted into ovate-oblong, obtuse, rounded, entire, incised, pinnatifid, or pinnately parted segments, the narrow divisions linear; fertile segment 1—3 pinnate, panicled, often very much branched; spores thickly covered with large rounded warts. Apex of both segments turned down in vernation; sterile segment clasping the fertile with its apex overlapping the whole. (Fig. 43). (B. neglectum, Wood). N. Eng., N. Y. and O. II.



Fig. 42. Vernation of B. lunaria, Swz. (After Davenport.)



Fig. 43. Vernation of B. matricariæfolium, A. Br. (After Davenport.)

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†† Buds pilose; sterile segments usually long-stalked.

B. ternatum, Swz. Frond fleshy, the common stalk very short; sterile segment broadly pentagonal or triangular, ternate: the three primary divisions also stalked, as broad as long, pinnately decompound; ultimate divisions varying from round-reniform to triangular-lanceolate, entire or variously toothed and incised; fertile segment longstalked, bi-quadripinnate. Apex of both segments bent down with a slight curve inward in vernation. (Fig. 44). (B. australe, R. Br., B. lunarioides, Swz., B. fumarioides, Willd., B. decompositum, Mart. and Gale., Osmunda ternata, Humb., Botrypus lunarioides, Michx.) N. Eng. and Can. westward to Br. Col. southward to Fla. III.

high, the fructification more compound; sterile segment with oblong or lanceolate divisions, either obtuse or oblique at the base, nearly entire, toothed or irregularly pinnatifid. (B. obliquum, Muhl.) N. Eng. to Wis, and southward. III.

Var. dissectum, Milde. Divisions of the sterile segment compoundly and laciniately cut into narrow small lobes and teeth, otherwise as the last. (B. dissectum, Muhl.) N. Eng. to Wis. and southward. III.

**** Vernation wholly inclined, in the fertile segment recurved.

segment recurved.

6. B. lanceolatum, Angs. Plant 3'—9' high, somewhat fleshy; sterile segment closely sessile at the top of a long common stalk, in the smallest forms three-lobed, in larger ones broadly triangular, twice pinnat-

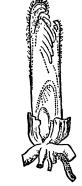


Fig. 44. Vernation of B. ternatum, Swz. (After Davenport.)



Fig. 45. Vernation of B. lanceolatum, Angs. (After Davenport.)

ifid, the divisions lanceolate, entire or toothed, all set at an oblique angle; fertile segment short-stalked, slightly overtopping the sterile, bi—tripinnate. Bud smooth; the fertile segment recurved its whole length, the shorter sterile segment reclined upon it. (Fig. 45). N. Eng. to Lake Superior and Col. III.

B. Virginianum, Swz. (RATTLESNAKE-FERN). Plant from

---TO

a few inches to two feet high; sterile segment sessile above the middle of the stalk, broadly triangular, thinly herbaceous, ternate; the short-stalked primary divisions once to twice pinnate, then once or twice pinnatifid; lobes oblong, cut-toothed toward the apex; fertile segment long-stalked, bi—tripinnate. Bud pilose, enclosed in a smooth upright cavity at one side of the lower part of the stalk; fertile segment recurved its whole length, the longer sterile segment reclined upon it. Reduced forms are B. gracile, Pursh, (Botrypus Virginicus, Michx., Osmunda Virginica, L.) N. B. to Fla. and westward to Pacific. III.

ORDER III. FILICES, Juss.

Vascular Cryptogamia with fronds usually raised on a stipe, usually from a prostrate, ascending or erect rootstock, circinate in vernation. Sporangia modified trichomes of the leaves, reticulated, one-celled, encircled by a more or less complete, jointed elastic ring, collected in clusters of various forms on the under surface of the frond, with or without an indusium or covering; or panicled or spiked and naked; or borne on receptacles of various kinds. Spores of various forms, minute. Prothallium above ground, green, monœcious.

SUB-ORDER I.—POLYPODIACEÆ, Presl.

Sporangia pedicelled, surrounded more or less completely by a jointed, vertical and elastic ring, bursting transversely. Sori dorsal or marginal, borne on a leafy frond, with or without indusia.

- TRIBE I. ACROSTICHEÆ. Sporangia spread in a stratum over the under surface, or rarely over both surfaces of the frond. Indusia wanting.
- I. Acrostichum, L. Sori covering the entire surface of the upper pinnæ.
- TRIBE II. POLYPODIEÆ. Sori dorsal, borne at or near the ends of the veinlets, without indusia.
 - II. Polypodium, L. Possessing characters of the tribe.
- TRIBE III. GRAMMITIDEÆ. Sori dorsal, variously arising from the veins, usually linear. Indusia absent.
- III. Gymnogramme, Desv. Sori oblong or linear, following the course of the veinlets.
- IV. Notholæna, R. Br. Sori on the veins or near their extremities, roundish or oblong, soon confluent into a narrow marginal band.

V. Tænitis, Swz. Sori linear, central or submarginal.

TRIBE IV. VITTARIEÆ. Sporangia borne in a continuous marginal or intra-marginal furrow.

VI. Vittaria, Sm. Fronds simple, linear, grass-like.

TRIBE V. PTERIDEÆ. Sori marginal or intra-marginal, provided with an indusium formed of the reflexed margin of the frond, and opening inwardly.

* Terrestrial.

- † Sporangia borne on a reflexed portion of the margin of the frond.
- VII. Adiantum, L. Sori usually numerous and distinct. Midrib of the pinnules near the lower margin or wanting.
- †† Sporangia borne on a continuous vein-like receptacle which connects the apices of the veins.
- VIII. Pteris, L. Sori continuous. Indusium delicate, whitish. Midribs of pinnules central.
- ††† Sporangia at or near the ends of unconnected veins, borne on the under surface of the frond.
- IX. Cheilanthes, Swz. Sori minute at the ends of the veins. Indusium continuous or interrupted.
- X. Cryptogramme, R. Br. Sporangia on the back or near the ends of the veins forming oblong or roundish sori, which are at length confluent and cover the back of the pinnules. Sterile and fertile fronds unlike, smooth.
- Xl. Pellæa, Link. Sori on the upper part of the veins, distinct, or mostly forming a marginal band of sporangia. Sterile and fertile fronds usually similar, smooth.

** Aquatic.

- XII. Ceratopteris,* Brong. Sori placed on two or three veins which run down the frond longitudinally. Indusia meeting at the midrib.
- TRIBE VI. BLECHNEÆ. Sori dorsal, linear or oblong, borne on transverse veins, parallel to the midrib. Indusium fixed at its outer margin, opening at the inner.

* Veins free.

XIII. Lomaria, Willd. Sori in a continuous band next the midrib. Indusium elongated, formed of the recurved and altered margin of the pinnæ, or else sub-marginal. Fronds of two sorts, elongated, pinnate.

^{*} This anomalous genus is placed provisionally among the *Pterideæ*, but it will probably demand a separate tribe for its reception. Prof. Eaton places it in a new sub-order CERATOPTERIDEÆ.

XIV. Blechnum, L. Sori linear, elongated, continuous near the midrib. Indusia continuous. Fronds pinnate.

** Veins more or less reticulated.

XV. Woodwardia, Sm. Sori linear or oblong, forming chainlike rows. Indusia separate.

TRIBE VII. ASPLENIEÆ. Sori dorsal, linear or oblong, oblique to the midrib, or rarely sub-parallel with it. Indusium fixed by one margin to the veinlet, opening at the other, sometimes double.

* Veins free.

XVI. Asplenium, L. Sori on the upper side of a fertile veinlet, rarely on both sides.

XVII. Scolopendrium, Sm. Sori linear, confluent in pairs, which appear like a single sorus with the double indusium opening in the middle.

** Veins reticulated.

XVIII. Camptosorus, Link. Sori oblong or linear, borne partly on veins parallel to the midrib, partly on veins oblique to the midrib.

TRIBE VIII. ASPIDIEÆ. Sori dorsal, round or roundish, on the back or rarely on the apex of a vein. Indusium usually membranous, rarely wanting.

* Without indusia.

XIX. Phegopteris, Fee. Sori round, rather small, borne on the back of the free veins.

** With indusia.

† Indusia superior.

XX. Aspidium, Swz. Indusium orbicular and fixed by the centre, or reniform and fixed by the sinus, opening all round the margin. Sori mostly on the back of the veins.

XXI. Nephrolepis, Schott. Indusium reniform, fixed at the sinus or at the arcuate base, opening toward the margin of the frond. Sori at the end of free veins.

†† Indusia fixed by a broad base partly under the sorus.

XXII. Cystopteris, Bernh. Indusium convex, usually reflexed as the sporangia ripen. Texture delicate.

††† Indusia obscure. Fertile frond much contracted, very unlike the sterile.

XXIII. Onoclea, L. Sori dorsal on the veins of the contracted pinnæ, concealed by their revolute margins.

†††† Indusia inferior.

XXIV. Woodsia, R. Br. Indusium roundish or stellate, delicate, cleft into irregular lobes.

TRIBE IX. DICKSONIE Æ. Sori roundish or transversely elongated, borne at the ends of the veins or on marginal crossveinlets, with an indusium attached at the base or base and sides and opening toward the margin af the segment.

XXV. Dicksonia, L'Her. Sori marginal, small, the indusium cup-shaped, somewhat two-valved, the under portion confluent with a lobule of the frond.

SUB-ORDER II.-HYMENOPHYLLACEÆ, Endl.

Sporangia borne on an elongated, often filiform, receptacle, surrounded by a complete transverse ring, opening vertically. Sori terminal or marginal from the apex of a vein. Indusium inferior, usually of the same texture as the frond. Fronds delicately membranous and pellucid.

XXVI. Trichomanes, Sm. Indusia tubular, cup-shaped, or funnel-shaped, sometimes two-lipped.

SUB-ORDER III. SCHIZÆACEÆ, Presl.

Sporangia ovate, sessile, arranged in spikes or panicles, having a complete, transverse, articulated ring at the apex, and opening by a longitudinal slit.

* Stems scandent.

XXVII. Lygodium, Swz. Sporangia borne in a double row on narrow fertile segments, each on a separate veinlet and provided with a special indusium.

** Stems not scandent.

XXVIII. Aneimia, Swz. Sporangia naked, attached by their bases to the narrow divisions of the panicled fertile segments of the frond.

XXIX. Schizæa, Sm. Sporangia naked, fixed in a double row to the midrib of the narrow fertile segments. Sterile fronds simple or dichotomously forked.

SUB-ORDER IV.—OSMUNDACEÆ, R. Br.

Sporangia naked, globose, mostly pedicelled, with no ring or mere traces of one around the apex, opening into two halves by a longitudinal slit.

XXX. Osmunda, L. Fertile pinnæ or fronds much contracted, bearing the large and abundant sporangia on the margins of the narrow segments.

ARTIFICIAL SYNOPSIS OF GENERA.

A	Sporangia collected in sori and borne on the back or margin of a leafy frond,	В
В	Sori covered with indusia,	C P
С	Fertile frond closely rolled together, entirely unlike the sterile, its segments berry-like or necklace-like. XXIII. ONOCLEA. Sori marginal, covered with a reflexed portion of the frond,	D H
D	Terrestrial, growing mostly in rocky places, Aquatic, sterile fronds floating on the water. XII. CERATOPTERIS.	E
E	Sporangia at the ends of the veins, borne on a reflexed portion of the margin of the frond. VII. Adiantum. Sporangia borne on a continuous, marginal, vein-like receptacle connecting the apices of the veins. VIII. Pteris. Sporangia at or near the ends of unconnected veins, borne on the under surface of the frond,	F
F	Fronds conspicuously dimorphous; stipes light-colored. X. Cryptogramme. Fronds nearly uniform; stipes usually dark,	r G
G	Sori on the upper part of the veins, mostly forming a continuous marginal band; indusium membranous, continuous round the segment. XI. Pellæa. Sori minute, at the ends of the veins; indusium interrupted, or if continuous, the ultimate segments usually small and bead-like; fronds mostly chaffy, woolly, or farinose. IX. Cheilanthes.	
н	Sori roundish; indusia not more than twice as long as broad,	I L

1	Indusium superior, attached by the centre or sinus, . Indusium convex, fixed by a broad base partly under the sorus. XXII. CYSTOPTERIS. Indusium inferior,	J ĸ
J	Sori mostly on the back of the veins; indusium orbicular or reniform, opening all round the margin. XX. ASPIDIUM. Sori at the end of a free vein; indusium reniform, opening toward the margin of the frond; fronds simply pinnate, the pinnæ articulated to the rachis. XXI. Nephrolepis.	
ĸ	Indusium roundish or stellate, delicate. XXIV. WOODSIA. Indusium cup-shaped, somewhat two-valved. XXV. DICKSONIA.	
L	Sori all parallel to the midribs or rachises, Sori all oblique to the midribs, Sori partly oblique and partly parallel to the midrib; frond simple, tapering to a point. XVIII. CAMPTOSORUS.	М О
M	Veins free,	N
N	Indisium near the margin; fertile frond much contracted. XIII. Lomaria. Indusium remote from the margin; fronds nearly uniform. XIV. BLECHNUM.	
o	Sori on the upper side of a veinlet, rarely on both sides. XVI. ASPLENIUM. Sori confluent in pairs, with an apparently double indusium opening in the middle. XVII. Scolopen-DRIUM.	
P	Sori spread in a stratum on the under surface of the frond. I. Acrostichum. Sori roundish, or not more than twice as long as broad, Sori usually linear, always more than twice as long as broad,	Q R
Q	Stipes articulated to the rootstock; fronds (in our species) entire or simply pinnate. II. Polypodium. Stipes not articulated to the rootstock; fronds (in our species) bi—tripinnatifid or ternate. XIX. Phegopteris.	

R	Fronds simple,	S T
s	Fronds very narrow, grass-like; veins indistinct, free. VI. VITTARIA. Fronds broader; veins anastomosing. V. Tænitis.	
T	Sori marginal, more or less confluent in a marginal band. IV. Notholæna. Sori following the veinlets, simple, forked, pinnated, or variously anastomosing. III. Gymnogramme.	
U -	Sporangia ovate, with transverse ring at apex, Sporangia globose without a ring. XXX. OSMUNDA.	v
v .	Stems scandent, pinnæ palmate. XXVII. LYGODIUM. Stems not scandent,	w
w -	Sporangia in close distichous spikes. XXIX. SCHIZÆA. Sporangia in copiously branching panicles. XXVIII. ANEIMIA.	

Note.—Species peculiar to North America are indicated by an asterisk (*). Roman numerals following the species indicate geographical sub-divisions. (See page 17).

I. ACROSTICHUM, L.

Sporangia spread over the whole surface of the frond or upper pinnæ, or occasionally over both surfaces. Venation and cutting various (in our species simply pinnate). Name from Gr. akron, the summit, and stichion, a row. A tropical genus containing 172 species.

& CHRYSODIUM.

1. **A. aureum**, L. Stipes $1^{\circ}-2^{\circ}$ long, tufted, strong, erect, glossy; fronds $2^{\circ}-6^{\circ}$ long, $1^{\circ}-2^{\circ}$ broad, upper pinnæ fertile, slightly smaller than the barren ones; texture coriaceous; areolæ small, copious, without free veinlets. Fla. VI.

II. POLYPODIUM, L. POLYPODY.

Sori round, naked, dorsal, in one or more rows each side of midrib, or irregularly scattered. Stipes articulated to rootstock. Name from Gr. *polus*, many, and *pous*, foot, alluding to the branching rhizoma. The largest, most cosmopolitan genus of ferns, containing 345 species.

& I. EUPOLYPODIUM. Veins free; fronds (in our species) pinnate.

* Sori large.

* Sori large.

* P. vulgare, L. Stipes 2'-4' long, firm, erect; fronds 4'-Ho' long, 1'-3' broad, cut nearly or quite to the rachis into entire for slightly toothed, usually blunt pinnæ; veins once or twice Merked. Larger fronds with their pinnæ sharply serrated and long pointed form the var. occidentale, Hook. N. Eng. westward to Ore, and southward to Ala. I.

- 2. P. falcatum,* Kellogg. Stipes 5'-8' long, stramineous; fronds 12'-15' long, 4'-8' broad; pinnæ numerous, tapering to a slender point, sharply serrate; sori nearest the midrib; veins with 2-4 veinlets. (P. glycyrhiza, D. C. E.) Cal. to W. T. IV. ** Sori smaller, often minute.
- 3. P. plumula, H B K. Stipes 1'-4' long, black, slender fronds narrowly lanceolate, 9'-18' long, 1'-2' broad; pinnæ numerous, narrow, entire, blunt, lower gradually reduced; surfaces naked except the black wiry rachis; veinlets forked, obscure. (P. elasticum, Rich.) Fla. VI.
- 4. P. pectinatum, L. Stipes rigid 2'-6' long; fronds elliptical-lanceolate, 1°-2½° long, 2'-6' broad, cut to the rachis into horizontal, entire or toothed pinnæ, the lower ones much reduced; rachis naked or finely villose; veinlets pellucid, once or twice forked; sori in long rows, of medium size. Fla. VI.
- & 2. Goniophlebium, Blume. Veins forming ample regular areolæ, (almost imperceptible in No. 5), each with a single distinct free included veinlet, bearing a sorus at its terminus.

* Under surface squamous.

5. P. incanum, Swz. Stipes 1'-4' long, erect, densely scaly; fronds 2'-6' long, 1'-11/2' broad, cut to the rachis into entire pinnæ; texture coriaceous; sori small; veins indistinct, united or frequently free. Va. to Ill. and southward. VI.

** Under surface mostly smooth.

- 6. P. Californicum,* Kaulf. Rootstock creeping, chaffy; stipes 2'-6' long, stramineous when dry, naked; fronds ovate to oblonglanceolate, 4'-9' long, 1'-5' broad, cut nearly or quite to midrib into finely-toothed pinnæ; teture papyraceo-herbaceous; sori large; veinlets 4-6 to each vein. (Including P. intermedium, H. & A.) Cal. IV.
- 7. P. Scouleri,* H. & G. Rootstock stout, creeping, scaly; stipes 2'-4' long, erect, naked; fronds thick, 3'-12' long, 2'-6' broad, cut down to rachis into from 5-29 close, blunt pinnæ; texture coriaceous, fleshy when recent; sori very large; veinlets regularly anastomosing forming a single series of large areolæ. (F.

carnosum, Kellogg, P. pachyphyllum, D. C. E.) Cal. and northward. IV.

- § 3. Phlebodium, R. Br. Veins forming ample areolæ, each with two or more distinct free included veinlets bearing sori on their united points.
- 8. P. aureum, L. Rootstock stout, densely scaly; stipes 1°—2° long, castaneous, naked; fronds 3°—5° long, 9′—18′ broad, cut nearly to the rachis into broad entire or slightly undulate pinnæ; areolæ copious. Fla. VI.
- § 4. CAMPYLONEURON, Presl. Primary veins distinct from midrib to the edge, connected by parallel transverse veinlets; areolæ similar, containing two or more sori.
- 9. P. Phyllitidis, L. Rootstock stout, scaly; stipes short or none; fronds simple, 1°-3° long, 1'-4' broad, the point acute, lower part gradually narrowed; texture rigid, coriaceous; areolæ in rows of 6—12 from midrib to edge. Fla. VI.
- § 5. Phymatodes, Presl. Areolæ fine, copious, irregular, the free veinlets spreading in various directions; sori various in position.
- 10. P. Swartzii, Baker. Rootstock wide creeping, slender, covered with linear ferruginous scales; stipes ½'-1' long, slender, naked; frond simple, 2'-4' long, ½'-¾' broad, narrowed gradually toward both ends, the edge entire, undulate, or slightly lobed; sori uniserial on free veinlets. (P. serpens, Swz.) Key Largo, Fla., March 1882. VI.

III. GYMNOGRAMME, Desv.

Sori oblong or linear, following the course of the veinlets and like them, simple, forked, pinnated, or variously anastomosing, without indusia. Name from Gr. gumnos, naked, and gramma, line. Includes 97 species mostly tropical.

- & I. EUGYMNOGRAMME. Veins free, under surface not farinose.
- 1. G. hispida, Mett. Rootstock creeping; stipes grayish, puberulent, 3'-6' long; fronds 5-angled, 1'-3' each way, hispid above, tomentose beneath, pinnate; lower pinnæ much the largest, unequally triangular, pinnate; upper pinnæ lobed or crenated, (G. pedata, of check lists not of Kaulf., G. podophylla, Hook. in part). Tex., N. Mex., Ariz. V.
 - § 2. CEROPTERIS, Link. Fronds farinose below.
- 2. G. triangularis, Kaulf. (GOLD-FERN, GOLDEN-BACK). Stipes densely tufted, slender, blackish-brown, polished, 6'-12' long;

fronds 2'-5' each way, deltoid, pinnate; lower pinnæ much the largest, triangular, bipinnatifid; upper pinnæ more or less pinnately lobed; lower surface coated with yellow or white powder, finally more or less obscured by the fruit. Cal. and northward. IV.

IV. NOTHOLÆNA, R. Br. CLOAK-FERN.

Sori marginal, at first roundish or oblong, soon confluent into a narrow band, without indusium, but sometimes covered at first by the inflexed edge of the frond. Veins free. Name from Lat. *nothus*, spurious, and *læna*, a cloak, alluding to the rudimentary indusia. Includes 37 species.

§ 1. Eunotholæna. Fronds not farinose beneath, scaly, hairy, or tomentose.

* Fronds simply pinnate.

- 1. N. sinuata, Kaulf. Rootstock short, thick, very chaffy; stipes 2'—4' long, erect; fronds 6'—2° long, 1'—2' broad; pinnæ numerous, short-stalked, roundish or ovate, entire to pinnately lobed, lower surface densely scaly. Tex. to Ariz. V.
- 2. N. ferruginea, Hook. Rootstock creeping, covered with dark rigid scales; stipes tufted, 2'-4' long, wiry, blackish, woolly at first; fronds 8'-12' long, $\frac{1}{2}'-1'$ broad, narrowly lanceolate; pinnæ numerous, ovate, pinnatifid, hairy above, densely tomentose beneath, the wool at first whitish, but becoming ferruginous. (N. rufa, Presl.) Tex. to Ariz. V.

** Fronds tri-quadripinnate.

- v 3. N. Parryi,* D. C. Eaton. Rootstock short, scaly; stipes 2'-4' long, dark brown, pubescent with whitish jointed hairs; fronds 2'-4' long, oblong-lanceolate, tripinnate, lower pinnæ distinct; segments crowded, roundish-obovate, one line broad, densely covered above with entangled white hairs, beneath with a heavier pale-brown tomentum. Utah, Cal., Ariz. V.
- 4. N. Newberryi,* D. C. Eaton. (COTTON-FERN). Rootstock with very narrow dark bristly scales; stipes tufted, 3'-5' long. blackish-brown, woolly when young, with pale ferruginous tomentum; fronds 3'-5' long, lanceolate-oblong, covered most densely beneath with fine whitish hairs, tri—quadripinnate; ultimate segments roundish-obovate, \(\frac{1}{3}'' \frac{1}{2}''' \) broad. Cal. IV.
- § 2. CINCINALIS, Desv. Fronds farinose, with white or yellow powder (in one species naked).
 - * Fronds farinose below.
 - † Fronds deltoid or pentagonal, barely bipinnate.
 - 5. N. candida, Hook, Rootstock creeping, with narrow, rigid,

- nearly black scales; stipes tufted, 3'—6' long, wiry, black and shining; fronds shorter than stipe, deltoid-ovate, pinnate, lowest pinnæ having the lowest inferior pinnules elongated and again pinnatifid, three or four next pairs of pinnæ lanceolate, pinnatifid into oblong segments; upper pinnæ like segments of the middle ones; segments whitish farinose beneath, green above, margin slightly revolute. (N. sulphurea, J. Sm., N. pulveracea, Kunze, Pteris sulphurea, Cav., Cheilanthes pulveracea, Hook.) Tex. to Cal. V.
- with rigid lanceolate dark-brown scales; stipes tufted, 4′—8′ long, reddish-brown, wiry, shining; fronds 2′—3′ each way, nearly pentagonal, composed of three divisions; the middle one slightly stalked, rhomboid-ovate, pinnatifid into a few toothed segments, the second pair larger than the first; the side divisions sessile, deltoid, pinnatifid on upper side as in middle division, but each bearing on the lower side a single large pinnatifid basal segment, and above it smaller segments like those of the upper side; lower surface covered with pale yellow powder. (*N. cretacea* of check lists not of Liebm., *N. candida*, var. 5-fido-palmato, Hook.) Tex. to Ariz. V.
- ++ Fronds lanceolate or linear-oblong, bipinnate or tripinnatifid · 7. N. Grayi,* Dav. Stipes tufted, 11/4'-31/2' long, terete, chestnut-brown, with nearly black, rigid, linear-acuminate scales below, paler, deciduous scales above; fronds 2'-4' long, 3/4'-11/4'broad, oblong-lanceolate, once or twice pinnate, upper surface sparingly, under thickly covered with white powder; rachises brown like the stipes, coated with a granular substance extending down the stipes, and clothed with long, slender, entire or ciliated, pale or whitish scales; pinnæ short-stalked, oblique, unequally triangular-ovate, ovate-lanceolate, or lanceolate, deeply pinnatifid or pinnately divided into 1 or 2 pairs of short-stalked or sessile, oblong, pinnatifid, obtuse pinnules, the remaining portion obliquely pinnatifid with alternate, lobed or entire segments; margins unchanged, reflexed; sori brown in a continuous line at the ends of the free veins. South-eastern Ariz. V.
- 8. N. Lemmoni,* D. C. Eaton. Rootstock short, scaly with narrow, pointed, rigid, dark-brown chaff; stalks dark reddish-brown, wiry, 4'—6' long, chaffy at the base with scales a little wider and more scarious margined than those of the rootstalk, otherwise smooth; fronds 6'—9' long, 1'—1½' wide, linear-oblong, pinnate with numerous deltoid or ovate, once or twice pinnatifid

pinnæ, the lowest ones a little shorter than the middle ones; upper surface herbaceous-green, smooth; lower surface covered with white or slightly yellowish ceraceous powder; sori forming a narrow sub-marginal line; margins of the segments very slightly recurved. Ariz. V.

††† Fronds deltoid-ovate, tri—quadripinnate at base. ‡ Rachises straight or nearly so.

- 9. N. dealbata,* Kunze. Stipes densely tufted, nearly black; rachis and all its branches straight, capillary; fronds deltoid-ovate, quadripinnate at base gradually simpler above; pinnæ mostly opposite; ultimate pinnules oval, entire or some of them 3-lobed. (Cheilanthes dealbata, Pursh.) Upper Missouri to N. Mex. and Ariz. V.
- scales; stipes tufted, 4'—6' long, wiry, black and polished; fronds 3'—6' long, 1½'—2' broad, pyramidal-ovate, tripinnate; primary pinnæ mostly opposite the rachises, nearly straight; pinnules long-stalked with blunt oblong or roundish, entire or more or less lobed segments; upper surfaces green, smooth, lower densely coated with pure white powder; sori brown, often descending the free veins half-way to the midvein. Ariz., N. Mex., 1880. V.

!! Rachises zigzag and flexuous.

• 11. N. Fendleri,* Kunze. Stipes densely tufted, dark-brown, 3'—5' long; rachis and all its branches zigzag and flexuous; fronds broadly deltoid-ovate, 3'—5' each way, quadripinnate below, gradually simpler above; pinnæ alternate; ultimate pinnules oval or elliptical, simple or 3-lobed. Col., N. Mex., Ariz. V.

** Fronds naked below.

'12. N. tenera, Gillies. Stipes tufted, brownish, smooth and shining; fronds 3'-4' long, ovtae-pyramidal, bi-tripinnate; pinnæ mostly opposite, distant, the lower ones somewhat triangular; ultimate pinnules ovate, often sub-cordate, obtuse, smooth and naked on both surfaces. Southern Utah. V.

V. TÆNITIS, Swz.

Sori linear, but the line sometimes interrupted, central or sub-marginal. Veins reticulated. Name from Lat. tænia, a band. Includes five species, all tropical.

1. T. lanceolata, R. Br. Rootstock creeping; stipes 1'-2' long; fronds simple, 6'-13' long, 1/2'-1/4' broad, tapering both ways, the edge entire or sometimes crisped, midrib prominent; veins immersed, the exterior free and clubbed at their apices;

sori ante-marginal, in a continuous line near the apex. (Lingua cervina, Plum., Pteris lanceolata, L., Pteropsis lanceolata, Desv., Neurodium lanceolatum, Fee). Fla. VI.

VI. VITTARIA, Sm. GRASS-FERN.

Sori linear, continuous, in two-lipped marginal grooves or in slightly intramarginal lines, with the unaltered edge of the frond produced beyond and often rolled over them, but without special indusia. Fronds narrow, grass-like. Veins free. Name from Lat. *vitta*, a fillet or head-band. A tropical genus containing 13 species.

- & TÆNIOPSIS, J. Sm.
- 1. V. lineata, Swz. Fronds 6'—18' long, 1''—5'' broad, narrowed gradually downward to a stout compressed stem, the edge often reflexed. Sori in a broad intramarginal line in a slight furrow, the edge of the frond at first wrapped over it. (V. angustifrons, Michx.) Fla. VI.

VII. ADIANTUM, L. MAIDENHAIR.

Sori marginal, short, covered by a reflexed portion of the more or less altered margin of the frond, which bears the sporangia on its under side from the approximated tips of free, forking veins. Name from Gr. a, without, and diainein, to wet, alluding to the smooth foliage. Includes 82 species mostly from Tropical America.

- & EUADIANTUM.
 - * Fronds at least bipinnate, pinnules flabellate or cuneate. † Fronds smooth.
- I. A. Capillus-Veneris, L. (Venus' Hair). Stipes nearly black, polished, very slender; fronds ovate-lanceolate, delicate, bipinnate, the upper half or third simply pinnate; pinnules and upper pinnæ wedge-obovate or rhomboid, rather long-stalked, the upper margin rounded and more or less incised, crenated, or acutely dentato-serrate, except where the margin is recurved to form the lunulate separated indusia. Va., Ky. and Fla. to Utah and Cal. VI.
- 2. A. tenerum, Swz. Stipes 1° high, erect, glossy; fronds 1° —3° long, 9′—18′ broad, deltoid, tri—quadripinnate; pinnules articulated to their petioles, falling off at maturity, cuneate, the upper edge rounded or somewhat angular, broadly often rather deeply lobed; sori numerous, roundish or transversely oblong. Fla. VI.
- 3. A. emarginatum,* Hook. Stipes rather stout, nearly black, polished; fronds ovate or deltoid-pyramidal, bi—tripinnate; pinnules and upper pinnæ ample, smooth or nearly so, rounded or

even reniform, upper margin rounded, slightly incised; sori 2-5, transversely linear-oblong, subcontinuous. (A. Chilense of check lists not of Kaulf., A. tenerum, Torr.) Cal. and northward. IV.

tt Fronds pilose with whitish hairs.

- 4. A. tricholepis, Fee. Stipes smooth, polished, deep black; fronds oval; pinnules roundish, moderately long petioled; sori few (3-7), of unequal size; indusia very velvety. (A. pilosum of check lists not of Fee, A. dilatatum, Nutt.) Western Tex. V.
- ** Fronds dichotomously forked, with numerous pinnæ springing from the upper side of the two branches.
- 5. A. pedatum, L. Stipes 9'—15' long, dark chestnut-brown, glabrous; fronds nearly circular in outline; central pinnæ 6'—9' long, 1'—2' broad; pinnules triangular-oblong, short-stalked; sori roundish or transversely oblong. N. C. to Cal. and northward. III.

VIII. PTERIS, L. BRAKE.

Sori marginal, linear, continuous, occupying a slender filiform receptacle which connects the tips of the free veins. Indusium membranous, formed of the reflexed margin of the frond. Name from Gr. pteris, a fern, from pteron, a wing, alluding to the prevalence of pinnate fronds. A cosmopolitan genus containing 103 species.

- § 1. Eupteris. Veins free, stipes tufted, indusium single.

 * Lower pinnæ linear, undivided.
- 1. P. longifolia, L. Stipes 6'—12' long, clothed more or less below with pale brown scales; fronds 1°—2° long, 4'—9' broad, oblong-lanceolate; pinnæ sessile, 2''—5'' broad, linear, entire; veins close and fine, usually once branched; indusium yellowishbrown. Fla. VI.

** Lower pinnæ forked or slightly pinnate below.

- 2. P. Cretica, L. Stipes 6'—12' long, erect, stramineous or pale-brown; fronds 6'—12' long, 4'—8' broad, lateral pinnæ usually in 2—6 opposite sessile pairs, the sterile ones considerably the broadest and spinulose-serrate, the lower pairs often cleft nearly to the base, into two or three linear pinnules; veins fine, parallel, simple or once forked; indusium pale. Fla. VI.
- 3. P. serrulata, Linn. f. Stipes 6'-9' long, naked, pale or brownish; fronds 9'-18' long, 6'-9' broad, ovate, bipinnatifid, the main rachis margined with a wing which is 1''-2'' broad at the top and grows narrower downwards; pinnæ in six or more distinct opposite pairs, upper ones simple, the lower ones with several long linear pinnules on each side, the edge of the barren ones spinulose-serrate; veins simple or once forked. Ala. VI.

& 2. PÆSIA, St. Hilaire. Veins free, rootstock creeping, stipes sub-distant, indusium more or less double.

4. P. aquilina, L. Rootstock stout, wide-creeping, subterranean; stipes 1°-2° high, erect, stramineous or brownish; fronds 2°-4° long, 1°-3° wide, ternate, the three branches each bipinnate; upper pinnules undivided, the lower more or less pinnatifid. North America everywhere. I.

Var. caudata,* Hook. Pinnules sometimes linear and entire, or with less crowded segments than the type and the terminal lobe linear and entire. (P. caudata, L.) N. I. to Fla. and Tex. VI.

Var. lanuginosa, * Hook. Fronds silky-pubescent or tomentose, especially on the under surface; otherwise as in the typical form. (*P. lanuginosa*, Bory.) Utah, Cal. and northward. IV.

IX. CHEILANTHES, Swz. LIP-FERN.

Sori terminal or nearly so on the veins, at first small and roundish, afterwards more or less confluent. Indusium formed of the reflexed margin of the frond, roundish and distinct or more or less confluent. Veins free. Name from Gr. cheilos, a lip, and anthos, flower, alluding to the lip-like indusia. A genus of 65 species of tropical and temperate zones.

- § 1. ADIANTOPSIS, Fee. Indusia distinct, roundish, confined to the apex of a single veinlet.
- r. C. Californica,* Mett. Rootstock short, creeping, chaffy; stipes densely tufted, dark-brown, glossy, 4'-8' long; fronds 4' or less each way, broadly deltoid-ovate, smooth on both surfaces, quadripinnatifid; lower pinnæ largest, triangular; upper ones gradually smaller and simpler; ultimate segments lanceolate, acute, incised or serrate; indusia membranous. (Aspidotis Californica, Nutt., Hypolepis Californica, Hook.) Cal. IV.
- & 2. Eucheilanthes. Indusia more or less confluent, usually extending over the apices of several veinlets, but not continuous all round the segments; segments mostly flat, not bead-like.

* Segments of the frond smooth.

† Pinnæ few, not more than 5-6 pairs.

2. **C.** Wrightii,* Hook. Stipes castaneous, slightly chaffy at base, 1'—2' high; fronds 2'—3' long, ovate-oblong, tripinnatifid, segments more or less incised; indusium sub-continuous or interrupted, similar to frond in texture. Western Tex. to Ariz. V.

tt Pinnæ numerous.

3. C. microphylla, Swz. Rootstock creeping, short; stipes dark-brown, glossy, rusty pubescent on the upper side, 4'-6'

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long; fronds 4'—6' long, ovate-lanceolate, bi—tripinnate; pinnæ lanceolate, the lowest ones usually largest and more deltoid; pinnules oblong or deltoid-ovate, deeply incised or pinnate; indusium similar in texture to frond, interrupted or sub-continuous. Fla., N. Mex. IV.

4. C. Alabamensis,* Kunze. Rootstock creeping, clothed with slender brown scales; stipes black with scanty ferruginous wool; fronds 2'—10' long, narrowly lanceolate, bipinnate; pinnæ close, ovate-lanceolate, the lowest ones not enlarged, usually smaller than those above; pinnules mostly acute, often auriculate on the upper side at the base; indusia pale, membranous, interrupted only by the incising of the pinnules. (Pellæa Alabamensis, Baker, Pteris Alabamensis, Buckley.) Va., Ala., Tenn. to Tex. VI.

** Segments of the frond glandular viscid.

5. C. viscida,* Dav. Stipes 3'—5' long, wiry, blackish, chaffy at the base with narrow ferruginous scales; fronds 3'—5' long, ¾'—1' broad, narrowly oblong, pinnate, with 4—6 distant pairs of nearly sessile, deltoid, bipinnatifid pinnæ; segments toothed, minutely glandular and everywhere viscid; teeth of segments recurved, forming indusia. Cal. IV.

*** Frond somewhat hairy and glandular not tomentose.

† Fronds deltoid-ovate; stipes stramineous.

6. C. leucopoda, Link. Stipes 3'-4' long, stout, chaffy at base; fronds 2'-4' long, deltoid-ovate, quadripinnate at base, gradually simpler above, everywhere glandular-puberulent; lowest pair of pinnæ unequally deltoid-ovate, upper ones oblong; pinnules short stalked; ultimate pinnules divided into minute rounded lobules, strongly revolute when fertile. Tex. V.

†† Fronds ovate-lanceolate; stipes brownish.

- 7. C. vestita,* Swz. Stipes tufted, 2'-4' long, wiry, chestnut-brown; fronds 4'-9' long, 1'-2' broad, tripinnatifid; pinnæ somewhat distant, lanceolate-deltoid; segments more or less thickly covered with acute hairs; sori copious; indusia formed of the ends of roundish or oblong lobes. (Nephrodium lanosum, Michx.) N. Y. to Kan. and southward to Ga. III.
- 8. C. Cooperæ,* D. C. Eaton. Stipes densely tufted, fragile, hairy with straightish nearly white articulated hairs which are usually tipped with a glandular and viscid enlargement; fronds 3′—8′ long, bipinnate, the pinnæ rather distant, oblong-ovate; pinnules roundish-ovate, crenate and incised, the ends of the lobules forming herbaceous indusia. Cal. IV.
 - § 3. Physapteris, Presl. Ultimate segments minute, bead-

like; indusium usually continuous all round the margin; fronds (in our species) bi—tripinnate, the lower surface scaly or tomentose or both.

*Fronds tomentose beneath, not scaly (except the rachises in No. 12).

† Upper surface naked or nearly so.

9. C. gracillima,* D. C. Eaton. (LACE-FERN.) Stipes densely tufted, 2'—6' long, dark-brown; fronds 1'—4' long, narrowly ovate-lanceolate, bipinnate; pinnæ numerous, crowded, pinnately divided into about nine oblong-oval pinnules, at first slightly webby above, soon smooth, heavily covered beneath with paleferruginous matted wool; indusia yellowish-brown, formed of the continuously curved margin. (C. vestita, Brack.) Cal., Ore., Br. Col. IV.

†† Upper surface decidedly pubescent.

‡ Stipes tomentose or smooth.

- ro. C. lanuginosa,* Nutt. Stipes densely tufted, slender, at first clothed with woolly hairs, at length nearly smooth; fronds 2'—4' long, ovate-lanceolate, tripinnate or tripinnatifid, rarely bipinnate; pinnæ deltoid below, oblong-ovate above, the lowest distant; ultimate pinnules minute, the terminal one slightly largest, crowded; upper surface scantily tomentose, the lower densely matted with whitish-brown, woolly hairs; indusia narrow formed of the unchanged margin. (C. lanosa, Eaton, C. vestita, Hook. in part, C. gracilis, Mett., Myriopteris gracilis, Fee.) Ill. to Tex., Ariz. and Br. Amer. V.
- 11. C. tomentosa, Link. Stipes tufted, 4'-6' long, rather stout, covered with pale-brown tomentum; fronds 8'-15' long, oblong-lanceolate, everywhere but especially beneath tomentose with slender, brownish-white, obscurely articulated hairs, tripinnate; pinnæ and pinnules ovate-oblong; ultimate pinnules ½''-¾'' long, the terminal ones twice as large; indusium pale, membranous, continuous. (C. Bradburii, Hook.) Va. to Mo. and Tex. III.
 - ‡‡ Stipe and rachises covered with very narrow scales.
- 12. **C. Eatoni**,* Baker. Stipes tufted, 3'—8' long, wiry, brownish; fronds 4'—8' long, oblong-lanceolate, tripinnate; lower pinnæ rather distant, upper crowded, ovate-oblong; ultimate pinnules contiguous, ½'' long, rounded, the terminal ones often twice larger; upper surface gray-tomentose, under surface with heavy matted ferruginous tomentum; indusia very narrow hidden by the tomentum. (*C. tomentosa*, Hook.) Tex. to Ariz. and Col. V.

- 13. C. Parishii,* Dav. Rootstock creeping, short, clothed with deep brown linear-lanceolate scales, with darker nearly black mid-nerves; stipes 2'—3' long, approximate, light to dark-brown, clothed at base with scales similar to those on the rootstock, passing gradually into broader pale-brown or nearly white nerveless scales, with more or less deciduous, slender, pale scales and chaff above; fronds 3'—4' long, 1'—1'4' broad, oblong-lanceolate, tri—quadripinnate, with both surfaces scantily clothed with a coarse tomentum; pinnæ alternate, oblong-ovate, obtuse, the lowermost somewhat distant; segments roundish, the terminal ones largest and three-lobed; indusia very narrow, only partially enclosing the sori. Cal. IV.
 - ** Fronds covered beneath with imbricated scales, not tomentose.
- 14. C. Fendleri,* Hook. Stipes 2'—5' long, chaffy with minute slender scales; fronds 3'—4' long, ovate-lanceolate, tripinnate; scales of primary rachis like those of stipe, those of secondary and ultimate rachises larger, broadly-ovate, entire or nearly so, usually edged with white, imbricated and overlapping the (¼''—1'3" broad) sub-globose ultimate segments; these are naked above, and commonly bear at their centre a single broad scale; indusium formed of the much incurved margin. Tex. and Col. to Cal. V.
- 15. C. Clevelandii,* D. C. Eaton. Stipes scattered, 2'-6' long, dark-brown, scaly when young, but at length nearly smooth; fronds 4'-6' long, ovate-lanceolate, tripinnate, smooth above, deep fulvous-brown below from the dense covering of closely imbricated, ciliated scales growing on the ultimate segments as well as on the rachises; segments nearly round, ½"-½" broad, the terminal ones larger, margin narrowly incurved. Cal. IV.
 - *** Under surface both tomentose and scaly.
- 16. C. myriophylla, Desv. Rootstock very short, scaly; stipes tufted, 2'—6' high, castaneous, covered with pale-brown scales and woolly hairs intermixed; fronds 3'—8' long, oblong-lanceolate, tri—quadripinnatifid, smooth or pilose above, beneath matted-tomentose and densely clothed with pale brown, narrowly ovate-lanceolate, ciliated scales, those of the ultimate segments with long tortuous cilia; pinnæ deltoid-ovate, narrower upwards; ultimate segments minute, ½'' broad, crowded, innumerable, the margin unchanged, much incurved. (C. elegans, Desv., C. palacea, Mart. and Gale.) Tex. to Nev. and Cal. IV.
- 17. C. Lindheimeri,* Hook. Rootstock long, slender, chaffy; stipes scattered, 4'-7' high, blackish-brown, at first covered with

scales and woolly hairs; fronds 3'—5' long, ovate-lanceolate, tri—quadripinnate; ultimate segments ½'' long, crowded; upper surface white tomentose, lower surface very chaffy, those of the midribs ciliate at base, those of the segments more and more ciliate passing into entangled tomentum. Western Tex. to Ariz. V.

- § 4. ALEURITOPTERIS, Fee. Indusia more or less confluent; fronds farinose below.
- 18. C. argentea, Kunze. Stipes densely tufted, 3'-6' long, castaneous; fronds 3'-4' long, 2' broad, deltoid, bi—tripinnatifid; lower pinnæ much the largest, cut nearly to the rachis; rachis polished like the stipe; upper surface naked, lower thickly covered with white powder; sori numerous, very small. Alaska. II.

X. CRYPTOGRAMME, R. Br. ROCK-BRAKE.

Sporangia on the back or near the ends of the free veins, forming oblong or roundish sori, which are at length confluent and cover the back of the pinnules. Indusium continuous, formed of the membranous somewhat altered margin of the pinnule, at first reflexed along the two sides and meeting at the midrib, at length opening out flat. Name from Gr. kruptos, concealed, and gramma, line, alluding to the concealed fructification. A boreal genus of two species.

1. C. acrostichoides,* R. Br. Stipes densely tufted, stramineous; fronds dimorphous, sterile ones on shorter stalks, tri—quadripinnatifid, with toothed or incised segments; fertile ones long-stalked, less compound, with narrowly elliptical or oblong-linear pod-like segments. (C. crispa, forma Americana, Hook., Allosorus acrostichoides, Spreng.) Lake Superior, Col. to Cal. and northward. II.

XI. PELLÆA, Link. CLIFF-BRAKE.

Sori intramarginal, terminal on the veins, at first dot-like or decurrent on the veins, at length confluent laterally, forming a marginal line. Indusium commonly broad and membranous, formed of the reflexed margin of the fertile segment. Name from Gr. pellos, dusky, alluding to the dark colored stipes. Includes 55 species.

- § 1. CHEILOPLECTON, Fee, Baker. Texture herbaceous or sub-coriaceous, veins clearly visible, indusium broad, in most of the species rolled over the sorus till maturity.
- r. P. Breweri,* D. C. Eaton. Stipes densely tufted, covered with narrow, crisped, fulvous chaff; fronds 2'—6' high, simply pinnate, the pinnæ short-stalked, 6—8 pairs, membranous, mostly

2-parted, the upper segment larger; segments obtuse, in the fertile frond narrower; indusium continuous, pale; veins repeatedly forked. Col. to Cal. and southward. IV.

- 2. P. gracilis, Hook. Stipes scattered, slender, 2'-3' long, stramineous or pale brown; fronds 2'-4' long, 1'-2' broad, ovate, bi-tripinnatifid; pinnæ lanceolate-deltoid, cut to the rachis into a few broad, blunt, slightly lobed pinnules; texture thinly herbaceous, flaccid; indusium broad, continuous, membranous; veins of the fertile fronds mostly only once forked. (Allosorus crispus, var. Stelleri, Milde, A. gracilis, Presl, Pteris gracilis, Michx., P. Stelleri, Gmelin.) Labrador to Pa., Ill., Col. and northward. II.
- § 2. Allosorus, Baker. Texture coriaceous, the veins not perceptible; indusium broad, conspicuous.
 - * Pinnules or segments obtuse or barely acute.
 - † Fronds pinnate or bipinnate, never tripinnate.
- 3. P. atropurpurea, Link. Stipes tufted, 2'—6' long, dark-purple; fronds 4'—12' long, 2'—6' broad, lanceolate or ovate-lanceolate, simply pinnate or bipinnate below; pinnules and upper pinnæ 1'—2' long, ¼' broad or less, nearly sessile, smooth; indusium formed of the slightly altered incurved edge of the pinnules. (Allosorus atropurpureus, Kunze, Pteris atropurpurea, L., Platyloma atropurpurea, J. Sm.) Ariz., N. Mex., Tex. to Vt. and northward. III.
- 4. P. aspera,* Baker. Stipes slender, 2'—3' long, black with scurfy pubescence; fronds 4'—6' long, oblong-lanceolate, bipinnate; pinnæ and pinnules deltoid-lanceolate or oblong, pinnules next to main rachis often lobed; all of them rough on both surfaces with short harsh hairs. (*Cheilanthes aspera*, Hook.) Western Tex. and N. Mex. V.
 - †† Fronds bi-quadripinnate, ultimate segments oval or cordate.
- 5. P. andromedæfolia, Fee. Stipes scattered, erect, pale brown, 2'—12' long; fronds 6'—12' long, 3'—6' broad, ovate, bi—quadripinnate usually tripinnate; pinnæ rather distant, spreading; ultimate pinnules 2''—5'' long, oval, slightly cordate, coriaceous, the margin of the fertile ones sometimes revolute to the midrib; veins numerous, parallel. (Allosorus andromedæfolius, Kaulf., Pteris andromedæfolia, Kaulf.) Cal. IV.
- 6. P. pulchella, Fee. Stipes densely tufted, 3'—8' long, chaffy at base, nearly black; fronds 3'—9' long, 1'—5' broad, triangular-ovate, quadripinnate below, gradually simpler above; lower pinnæ deltoid, narrowly triangular above; ultimate pinnules numerous,

1"-3" long, oval or often cordate-ovate, stalked, coriaceous smooth, the edges often much reflexed. (Allosorus pulchellus, Mart, and Gale.) Western Tex. and N. Mex. V.

** Pinnules mucronulate or decidedly acute.

† Fronds narrowly linear in outline, usually bipinnate.

- 7. P. ternifolia, Link. Stipes tufted, nearly or quite black, 2'—6' long, fronds 4'—10' long, narrowly linear; pinnæ usually 9—15 pairs, all but the uppermost trifoliate; segments commonly linear, slightly mucronate, coriaceous, sessile or the middle one indistinctly stalked, the edges much inflexed in fertile fronds; indusium broad. (*Pleris ternifolia*, Cav.) Western Tex. V.
- 8. P. brachyptera,* Baker. Stipes 2'—8' long, stout, purplishbrown; fronds 3'—8' long, narrow in outline from the ascending secondary rachises, bipinnate; pinnules crowded, 2''—5'' long, oblong-linear, simple or trifoliate, acute or mucronulate; margins inflexed to the midrib in fertile fronds. (P. Ornithopus, var. brachyptera, D. C. E., Platyloma bellum et P. brachypterum, Moore.) Cal. IV.

†† Fronds broader, lanceolate to ovate, bi-tripinnate.

- 9. P. Ornithopus,* Hook. Stipes tufted, 3'—8' long, rather stout, dark-brown; fronds very rigid, 3'—12' long, 2'—3' broad, broadly deltoid-lanceolate, bi—tripinnate; primary pinnæ spreading or obliquely ascending, linear, bearing 4—16 pairs of trifoliate (varying from simple to 5—7 foliate) mucronulate pinnules, 1½"—2'' long; margins inflexed to midrib in fertile fronds. (Allosorus mucronatus, D. C. E.) Cal. IV.
- 10. **P. Wrightiana**, Hook. Rootstock short, thick, densely chaffy; stipes crowded, purplish-brown, 4'-6' long; fronds 3'-6' long, 1'-3' broad, lanceolate to deltoid, bipinnate; pinnæ nearly sessile, spreading; pinnules coriaceous, smooth, nearly sessile, at most about six pairs; those of the sterile frond oval, 3''-5'' long, with a minute cartilaginous point; of the fertile inflexed to the midrib. (*P. longimucronata*, Hook., *P. mucronata*, Baker, *P. Weddelliana*, Fee.) Tex.. Col., N. Mex., Ariz. V.
- 11. P. densa,* Hook. Rootstock rather slender, chaffy with blackish scales; stipes densely tufted, wiry, very slender, castaneous, 3'—9' long; fronds ovate or triangular-oblong, 1'—3' long, densely tripinnate; segments 3''—6'' long, linear, nearly sessile, sharp pointed or mucronate, in the fertile fronds entire, with the margin narrowly recurved, in the rare sterile fronds sharply serrated, especially toward the apices. (Onychium densum, Brack.) Cal., Ore., Wy. T., Canada. IV.

- § 3. Platyloma, J. Sm., Baker. Texture coriaceous, the veins usually hidden, the ultimate segments broad and flat, the indusium so narrow as to be soon hidden by the fruit.
- 12. P. Bridgesii,* Hook. Stipes 2'-6' long, tusted, castaneous; fronds 4'-6' long, I' or more broad, simply pinnate; pinnæ 5-18 pairs, mainly opposite, nearly sessile, glaucous green, coriaceous, rounded or cordate at the base; indusium narrow, formed of the whitish margin of the pinna, soon flattened out exposing the broad sorus. Cal. IV.
- 13. P. flexuosa, Link. Rootstock creeping, rather slender, stipes reddish, passing into a more or less flexuous or zigzag rachis; fronds 6'—30' long, ovate-oblong, bi—tripinnate; secondary and tertiary rachises usually deflected and zigzag, rusty puberulent or nearly smooth; pinnæ mostly alternate; ultimate pinnules 5''—10'' long, roundish-ovate, or sub-cordate, smooth; margins at first reflexed, soon flattened out. (Allosorus flexuosus, Kaulf.) W. Tex. to Cal. V.

XII. CERATOPTERIS, Brong. FLOATING-FERN.

Sori placed on two or three veins which run down the frond longitudinally, nearly parallel with both the edge and midrib. Sporangia scattered on the receptacles, sessile, sub-globose, with a complete, partial or obsolete ring. Indusia formed of the reflexed margins of the frond, those of opposite sides meeting at the midrib. Name from Gr. keras, horn, and pteris, a fern. Contains a single tropical species.

1. C. thalictroides, Brong. Stipes tufted, thick, inflated, filled with large air cells; fronds succulent in texture, the sterile ones floating in quiet water, simple or slightly divided when young, bi—tripinnate when mature; fertile ones bi—tripinnate; ultimate segments pod-like. Fla. VI.

XIII. LOMARIA, Willd.

Sori in a continuous band next the midrib of the contracted pinnæ of the fertile frond, covered till mature by an elongated indusium, either formed of the recurved and altered margin of the pinna or sub-marginal and parallel to the margin. Veins of sterile frond oblique to the midrib, simple or forked and free. Fronds mostly elongated, of two kinds, the sterile foliaceous, the fertile commonly much contracted. Name from Gr. *loma*, a fringe, *aria*, diminutive. Principally south temperate, containing 45 species.

- & EULOMARIA.
- I. L. spicant, Desv. (DEER-FERN.) Rootstalk short, thick,

very chaffy; fronds tufted, erect, sterile ones nearly sessile, narrowly linear-lanceolate, 8'—24' long, 1'—3' wide, tapering to both ends, cut to the rachis into oblong or oblong-linear closely set segments, the lower ones gradually diminishing to minute auricles; fertile fronds sometimes three feet high, long-stalked, pinnate; pinnæ somewhat fewer and more distant, longer and much narrower than in the sterile frond; indusia distinctly intramarginal (Osmunda spicant, L., Blechnum boreale, Swz.) Cal., Ore. and northward. IV.

XIV. BLECHNUM, L.

Sori linear, continuous or nearly so, parallel with the midrib and usually contiguous to it. Indusium membranous, distinct from the edge of the frond. Veins usually free. Name from Gr. blechnon, an old name for some kind of fern. A tropical and south temperate genus, containing 19 species.

& Eublechnum.

1. B. serrulatum, Michx. Stipes 6'—12' long, stout, erect, nearly naked; fronds oblong-lanceolate, 1°—1½° long, 3'—6' broad, with 12—24 pairs of distinct linear-oblong pinnæ, the margins finely incised; texture coriaceous; veins very fine and close; feetile pinnælna rower. (Blechnum augustifolium, Willd.) Fla. VI.

XV. WOODWARDIA, Sm. CHAIN-FERN.

Sori oblong or linear, sunk in cavities in the frond, arranged in a chain-like row parallel to the midribs of the pinnæ and pinnules and near them. Indusium sub-coriaceous fixed by its outer margin to the fruitful veinlet and covering the cavity like a lid. Veins more or less reticulated. Named for *Thomas J. Woodward*, an English botanist. Containing six species mostly north temperate.

- § 1. EUWOODWARDIA. Fronds uniform, the veins forming at Least one series of areolæ between the sori and margins.
- 1. W. radicans, Sm. Caudex stout, erect, and rising a little above the ground; stipes stout, 8'—12' long; fronds 3°—5° high, subcoriaceous, pinnate; the pinnæ 8'—15' long, 2'—4' broad, oblique to the rachis, pinnatifid nearly to the midrib; segments spinuloseserrate; veinlets forming a single row of oblong sorus-bearing areolæ next the midvein, besides a few oblique empty areolæ outside the fruiting ones, thence free to the margin. Cal., Ariz. IV.
- & 2. Anchistea, Presl. Fronds uniform, the veins free between the sori and the margins.
- 2. W. Virginica,* Sm. Stipes stout, 12'—18' high; fronds oblong-lanceolate, 12'—18' long, 6'—9' broad; pinnæ linear-lan-

ceolate, 4'-6' long, ¾'-1' broad, cut nearly to the rachis into linear-oblong lobes. (W. Banisteriana, Michx., Blechnum Carolinianum, Walt., B. Virginicum, L., Doodia Virginica, Presl.) Canada and Fla. westward to Mich. and Ark. III.

§ 3. LORINSERIA, Presl. Fronds dimorphous, veins everywhere forming areolæ.

3. W. angustifolia,* Sm. Sterile frond with slender stipes, 9'—12' long, 6'—8' broad, deltoid-ovate, with numerous oblong-lanceolate sinuate pinnæ; rachis broadly winged; fertile frond with an elongated, castaneous stem; pinnæ 3'—4' long, narrowly linear. (W. onocleoides, Willd., W. areolata, Moore, Acrostichum areolatum, L.) Me. to Fla., Mich., Ark. III.

XVI. ASPLENIUM, L. SPLEENWORT.

Sori oblong or linear, oblique, separate; indusium straight or rarely curved, opening toward the midrib when single, sometimes double. Veins free in all our species. Name from Gr. a, without, and *splen*, spleen. A cosmopolitan genus containing 331 species.

§ 1. Euasplenium. Veins free, simple or branched; indusium straight or slightly curved, attached to the upper side of a vein.

* Fronds simple.

1. A. serratum, L. Fronds growing in a crown from a short, stout, erect rootstock, $1\frac{1}{2}^{\circ}-2\frac{1}{2}^{\circ}$ long, $2^{\prime}-4^{\prime}$ broad, simple, spatulate or linear-oblanceolate, the margin crenulate or irregularly but finely serrate, sub-coriaceous; midrib prominent, keeled and often blackish purple beneath; veins closely placed, free, once forked; sori much elongated, following the veins of the upper half of the frond from near the midrib half way to the margin; indusia single, the free edge entire. Fla. VI.

Fronds pinnatified or pinnate below, tapering to a point.

2. A. pinnatifidum,* Nutt. Stipes tufted, 2'-4' long; fronds 3'-6' long, 1'-1½' broad, lanceolate, pinnatified, or pinnate below, tapering to a slender prolongation above; lobes roundish-ovate, or the lowest pair acuminate; sori numerous. Pa. to Ill., Ky. and Ala. III.

3. A. ebenoides,* R. R. Scott. Fronds 4'—9' long, broadly lanceolate, pinnatifid, pinnate below; apex prolonged and slender; divisions lanceolate from a broad base, the lower ones shorter; stipes black and polished, as is the lower part of the midrib especially beneath. N. Y., Pa., Ct., Ala., Ky., Ill. III. Rare.

*** Fronds once pinnate.

† Pinnæ ¼'—¾' long, mostly blunt. ‡ Rachis chestnut-brown or blackish.

- 4. A. ebeneum, Ait. Stipes tufted, 3'—6' long, chestnutbrown, nearly naked; fronds 8'—16' long, linear-lanceolate; pinnæ 20—40, lanceolate, subfalcate, or the lower oblong, ½'—1' long, the dilated base auricled on the upper or both sides; sori often 10—12 on each side. (A. trichomanoides, Michx.) Canada to Fla., Ky. and northward. III.
- 5. A. parvulum, Mart. & Gale. Fronds tufted, erect, rigid, 4'—10' long, narrowly linear-lanceolate; stipe and rachis black and shining; pinnæ numerous, oblong, obtuse, entire or crenulate, auricled on the upper side, nearly sessile; middle pinnæ longest, the lower gradually shorter and deflexed; sori short, abundant. (A. ebeneum, var. minus, Hook., A. resiliens, Kunze.) Va., S. C. and Fla. to Ark. and N. Mex. VI.
- shining; fronds 3'—8' long,½' or more broad, linear; pinnæ 15—30 pairs, nearly opposite, roundish-oblong or oval, the two sides unequal, obliquely wedge-truncate at the base, attached by a narrow point, the edge slightly crenate, the midvein forking and evanescent; sori 3—6 on each side of the midrib. (A. melanocaulon, Willd.) Eastern U. S. to the Pacific coast. I.

Var. incisum, Moore. Fronds larger, often 1/2 or more broad, pinnæ more or less deeply incised. Cal., Vt.

- 7. A. viride, Huds. Stipes densely tufted, 2'—4' long, naked, the lower part chestnut-brown; fronds 2'—6' long, ½' broad, with 12—20 pinnæ on each side, which are ovate or rhomboidal in outline, the upper edge narrowed suddenly at the base, the lower obliquely truncate, the outer part deeply crenated; rachis naked; sori copious. Vt., Canada, and N. B. II.
- 8. A. dentatum, L. Stipes tufted, 2'-6' long, naked, ebeneous below; fertile fronds 2'-3' long, 1' broad, with 6-8 pairs of stalked, oblong-rhomboidal pinnæ, the lower side truncate with a curve, the outer edge irregularly crenate; sterile fronds smaller on shorter stipes; rachis naked; sori copious in parallel rows. Fla., S. C. VI.

†† Pinnæ only 2--5, linear-cuneate.

9, A. septentrionale, Hoffm. Stipes densely tufted, 3'-6' long, slender, naked, ebeneous toward the base; fronds irregularly forking, consisting of two to five narrowly linear rather rigid segments, which are entire or more frequently cleft at the end into a few long narrow teeth; sori much elongated, placed near the margin, usually facing each other in pairs, commonly only two or three to each segment. Col., N. Mex. V.

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Jane .

- ††† Pinnæ numerous, linear or linear-oblong, acute or acuminate.
- 10. A. angustifolium,* Michx. Stipes 1° or more long, brownish, slightly scaly below; fronds 1½°-2°·long, 4′-6′ broad, lance-olate-oblong, flaccid; pinnæ 20-30 pairs, linear-lanceolate, acuminate, entire or crenulate, those of the fertile frond narrower texture thinly herbaceous; sori linear, 20-40 each side of the midvein. N. Eng. to Ky. and Wis. III.
- 11. A. firmum, Kunze. Stipes 4'—8' long, erect, grayish, naked; fronds 6'—12' long, 3'—4' broad; pinnæ 12-20 pairs, oblong-lanceolate, the point bluntish, the margin inciso-crenate, the upper one narrowed suddenly at the base, the lower one obliquely truncate; sori short, falling short of both midvein and margin. Fla., Ariz. VI.

**** Fronds bi--tripinnatifid.

† Texture somewhat coriaceous.

- 12. A. Ruta-muraria, L. Stipes tufted, 2'-4' long, naked; Konds ovate-deltoid, 1'-2' long, bi—tripinnate below, simply pinnate above; the divisions rhombic-wedge-shaped, toothed or incised at the apex; veins flabellate; sori few, elongated, soon confluent. Vt. to Mich. and Ky. III.
- 13. A. montanum,* Willd. Stipes tufted, 2'-3' long, naked; fronds 2'-5' long, ovate-lanceolate, pinnate; pinnæ 3-7 parted below, incised or toothed above; veins obscure; sori short, the basal ones sometimes double. N. Y. to Ky., Ala, and Ark. III.
 - †† Texture thinly herbaceous or membranous.
 - 14. A. Bradleyi,* D. C. Eaton. Stipes tufted, 2'—3' long, ebeneous, as is also the lower half of the rachis; basal scales brown-black, lanceolate-acuminate; fronds 3'—7' long, oblong-lanceolate, bipinnatifid; pinnæ 8—12 pairs, short-stalked or sessile, ovate-oblong, the lowest not reduced, the largest pinnatifid with oblong lobes toothed at the tip; sori short, near the midvein. N. Y., E. Tenn., Ky. and Ark. III.
 - 15. A. myriophyllum, Presl. Stipes tufted, 2'—6' long; fronds 3'—10' high, delicately membranous, lanceolate, narrowed below, bi—tripinnate; ultimate segments obovate-oblong, entire or 2—3 lobed; veins single in each segment, bearing below the middle a solitary oblong sorus. Fla. VI.
 - 16. A. cicutarium, Swz. Stipes tufted, 4'--8' long, greenish, naked; fronds 6'—15' long, 4'--6' broad, with 10—15 horizontal pinnæ on each side, the lower ones 2'—3' long, 1' broad, cut down to the rachis into linear or oblong segments, which are once or twice cleft at the apex; rachis compressed and often winged; sori principally in two rows. Fla, VI.

- § 2. Athyrium, Roth. Veins free; sori more or less curved, sometimes horseshoe-shaped, often crossing to the outer or lower side of the fruiting veinlet.
- 17. A. thelypteroides, Michx. Stipes long, erect, stramineous; fronds 1°-2° long, 6'-12' broad, bipinnatifid; pinnæ linear-lanceolate; segments crowded, oblong, minutely toothed; sori 5-6 pairs to each segment, slightly curved, the lower ones often double. N. Eng. to Ky. and Ill. III.
- 18. A. filix-femina, Bernh. (LADY-FERN). Stipes tufted, 6'—12' long, stramineous or brownish; fronds delicate, 1½°—3° long, broadly oblong-ovate, bipinnate; pinnæ 4'—8' long, lanceolate; pinnules oblong-lanceolate, pointed, more or less pinnately incised or serrate, distinct or confluent on the secondary rachises by a very narrow and inconspicuous margin; sori short; indusium straight or variously curved. Small starved specimens growing in mountainous places form the var. exile, D. C. Eaton, often fruiting when 3'—6' high. Narrow forms with the pinnæ obliquely ascending are var. Michauxii, Max. (vax. angustum, D. C. E.) and other forms equally as unimportant form the remaining sixty-three varieties that have been described of this species. (Aspidium filix-fæmina, Swz., Nephrodium asplenoides, Michx.) Eastern U. S. to Utah, Nev., Cal. and Ariz. I.

XVII. SCOLOPENDRIUM, Sm. HART'S-TONGUE.

Sori linear, elongated, almost at right angles to the midvein, contiguous by twos, one on the upper side of one veinlet, and the next on the lower side the next superior veinlet, thus appearing to have a double indusium opening along the middle. Name from Gr. skolopendra, a centipede, alluding to the position of the sori. Includes five species.

1. S. vulgare, Sm. Stipes 2'-6' long, fibrillose below; fronds oblong-lanceolate from an auricled-heart-shaped base, entire or undulate, 7'-18' long, 1'-2' wide, bright green. (S. officinarum, Swz., Asplenium scolopendrium, L.) Central N. Y., Canada, Tenn. II.

XVIII. CAMPTOSORUS, Link. WALKING-LEAF.

Sori oblong or linear, irregularly scattered on either side of the reticulated veins of the simple frond, those next the midrib single, the outer ones inclined to approximate in pairs, or to become confluent at their ends, thus forming crooked lines. Name from Gr. kamptos, curved, and soros, a heap. Includes only two species.

I. C. rhizophyllus,* Link. Fronds evergreen, tufted, spreading

or procumbent, 4'-9' long, lanceolate from an auricled, heart shaped or often hastate base, tapering above into a slender prolongation which often roots at the apex. (Antigramma rhizophylla, J. Sm., Scolopendrium rhizophyllum, Hook., Asplenium rhizophyllum, L.) N. Eng. to Wis. and southward. III.

XIX. PHEGOPTERIS, Fee. BEECH-FERN.

Sori small, round, naked, borne on the back of the veins below the apex. Stipe continuous with the rootstock. Veins free in our species. Name from Gr. phegos, a beech-tree, and pteris, a ferno Includes 95 species.

*Fronds triangular, bipinnatifid; pinnæ sessile, adnate to a winged rachis.

than broad, 4'—9' long, 4'—6' broad, hairy on the veins especially beneath; pinnæ linear-lanceolate, the lowest pair deflexed and standing forward; segments oblong, obtuse, entire, the basal ones decurrent and adnate to the main rachis; sori near the margin. (P. vulgaris, Mett., Polypodium Phegopteris, L., P. connectile, Michx.) N. Eng. to Va. and westward. II.

2. P. hexagonoptera,* Fee. Stipes 8'—18' long, stramineous, naked; fronds as broad as long or nearly so, 7'—12' long, slightly pubescent, and often finely glandular beneath; upper pinnæ oblong, obtuse, toothed or entire, the very large lowest pinnæ elongated and pinnately lobed; sori near the margin or some between the sinus and the midrib. (*Polypodium hexagonopterum*, Michx.) Canada to Ill., Ky. and Fla. III.

** Fronds oblong-lanceolate, tripinnatifid; rachis wingless.

3. P. alpestris, Mett. Rootstock short, thick, erect or oblique; stipes 4'—10' long, with a few brown spreading scales near the base; fronds 1°—2° long, pinnæ deltoid-lanceolate, the lower ones distant and decreasing moderately; pinnules oblong-lanceolate, incised and toothed; sori small, rounded, sub-marginal. (Polypodium alpestre, Hoppe, Aspidium alpestre, Swz.) Cal. and northward. IV.

*** Fronds ternate, the three divisions petioled; rachis wingless.

P. Dryopteris, Fee. (OAK-FERN). Rootstock slender, creeping fronds broadly triangular, 4'-8' wide; the three primary divisions 1—2 pinnate; segments oblong, obtuse, entire or toothed; sori near the margin. (Polypodium Dryopteris, L., Nephrodium Dryopteris, Michx.) Northeastern U. S. to Va. and westward to Ore, and Alaska. II.

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5. P. calcarea, Fee. Stipes 6'—10' long, stramineous when dry, glandular; fronds 6'—8' long, 5'—7' wide, deltoid-ovate in outline, bipinnate, lowest pair of pinnæ far the largest, pinnatifid or again pinnate; upper pinnæ smaller, pinnatifid, lobed, or entire; sori copious forming submarginal rows around the segments. Minn., Iowa. II.

XX. ASPIDIUM, Swz. SHIELD-FERN. WOOD-FERN.

Sori round, borne on the back or rarely at the apex of the veins. Indusium flat or flattish, orbicular and peltate at the centre, or cordato-reniform and fixed either centrally or at the sinus. Stipe continuous with the rootstock. Name from Gr. aspidion, a small shield. A cosmopolitan genus containing 344 species.

- & I. EUASPIDIUM. Veins anastomosing copiously.
- 1. A. trifoliatum, Swz. Stipes tufted, 1° or more long, brownish, scaly at base; fronds 12′—18′ long, 6′—12′ broad, with a large ovate-acuminate terminal pinna narrowed or forked at the base, and one or two lateral ones on each side, the lowest mostly forked; primary veins distinct to the margin; areolæ fine, copious, with free included veinlets; sori in rows near the main veins; indusia orbicular, peltate. Fla., W. Tex. VI.
- § 2. Cyrtomium, Presl. Indusium peltate; fronds simply pinnate with broad pinnæ; veinlets usually uniting slightly near the margin.
- 2. A. juglandifolium, Kunze. Stipes tufted, clothed below with large scales; fronds 6'—2° long, coriaceous; pinnæ 2—12 pairs, short-stalked, ovate-oblong or broadly lanceolate, the terminal one distinct, and in small fronds the largest, appressed-serrulate, smooth on both surfaces; veins pinnated, the veinlets few, free or uniting near the margin; sori scattered in several irregular rows. Western Tex. V.
- § 3. Polystichum, Roth. Indusium orbicular and entire, peltate, fixed by the depressed centre; pinnæ and pinnules usually auricled on the upper side at base, mucronately serrate; veins free.

 *Fronds simply pinnate.

† Fronds long-stalked, lanceolate.

3. A. acrostichoides,* Swz. (Christmas-fern). Stipes 6′—8′ long, densely clothed below with pale brown lanceolate scales, fronds ½°—2° high, 3′—5′ broad; pinnæ linear-lanceolate, somewhat falcate, half-halberd shaped at the base, serrulate with appressed bristly teeth; the fertile ones contracted and smaller, bearing contiguous sori near the middle, soon covering the entire

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surface. A form with cut-lobed, often strongly falcate pinnæ, set obliquely to the rachis, and with the tips of nearly all bearing sori, is the *var. incisum*, Gray. (*Nephrodium acrostichoides*, Michx.) N. Eng. to Fla., Miss. and northward. III.

4—A. munitum,* Kaulf. Stipes 4'—12' long, chaffy like the rachis with brown scales; fronds growing in a crown, 1°—4° long, tapering slightly toward the base; pinnæ numerous, linear-acuminate, 3'—4' long, very sharply and often doubly serrate, with appressed needle-like points; sori numerous forming a single row each side of the midrib half-way to the margin. Cal. and northward. IV.

†† Fronds scarcely stalked, linear-lanceolate.

5. A. Lonchitis, Swz. (HOLLY-FERN). Fronds 9'—20'long, rigid; pinnæ 1' or more long, broadly lanceolate-falcate or the lowest triangular, strongly auricled on the upper side, the lower obliquely truncate, densely spinulose-toothed; sori contiguous and near the margin. Canada and Wis. to Utah, and northward. II.

** Fronds bipinnate or nearly so.

- 6. A. mohrioides, Bory. Stipes tufted, 2'-6' long, more or less densely clothed with lanceolate dark-brown scales; fronds 6'-12' long, 2'-3' broad, with numerous dense, often imbricated, lanceolate pinnæ, which are cut below into slightly toothed oblong-rhomboidal pinnules; teeth blunt or mucronate; texture coriaceous; both surfaces naked; rachis stout, compressed, scaly; veins close, immersed; sori copious. Cal. IV.
- 7. A. aculeatum, Swz. Rootstock stout, erect; stipes variable in length, very chaffy with large and small scales intermixed as in the rachis; fronds 1°—2° long, growing in a crown, oblong-lanceolate, pinnate; pinnæ closely placed, lanceolate from a broad base, mostly curved upwards, incisely pinnatifid or again pinnate; segments or pinnules of variable shape, oval-rhomboidal, or unequally triangular-ovate and auriculate on the upper side of the slightly stalked base, the teeth aculeate in various degrees; under surface more or less chaffy-fibrillose; sori in two rows on the segments nearer the midvein than the edge. Cal. IV.

Var. Californicum, D. C. Eaton. Fronds elongated, narrow, tapering slightly at the base; pinnæ but slightly incised above the middle, more and more deeply cleft toward the rachis, the lower superior segment largest, but scarcely distinct as a pinnule, and not at all auricled. (A. Californicum, D. C. E.) Cal. IV.

Var. angulare, D. C. Eaton. Fronds oblong-lanceolate, scarcely or not at all narrowed at the base, truly bipinnate; pinnules

distinctly short-stalked, mostly auricled and slightly incised; the basal one largest and again pinnatifid; under surface chaffy-fibrillose. (A. angulare, Willd.) Cal. IV.

Var. Braunii, Koch. Fronds oblong-lanceolate; pinnæ numerous, oblong-lanceolate, the lower gradually reduced in size and obtuse; pinnules ovate or oblong, truncate and almost rectangular at the base, sharply toothed, beset with long soft hairs as well as chaffy ones. (A. Braunii, Spenner.) Me. to N. Y. and northward. II.

- § 4. Nephrodium, Rich. (Dryopteris, Adans.) Indusium cordato-reniform or orbicular with a narrow sinus.
- * Texture thin-membranous, veins simple or once forked, fronds bipinnatifid.
 - † Lowest pinnæ gradually reduced to mere lobes.
- 8. A. Noveboracense,* Swz. Rootstock slender, creeping; fronds 1°-2° long, 4'-6' broad, lanceolate, tapering both ways from the middle; pinnæ lanceolate, the lowest two or more pairs gradually shorter and deflexed, those of the barren frond broader; segments flat, oblong, basal ones often enlarged; veins simple or forked in basal lobes; sori distinct, near the margin; indusium minute, the margin glanduliferous. (A. thelypteroides, Swz., Polypodium Noveboracense, L., Nephrodium Noveboracense, Desv., Lastrea Noveboracensis, J. Sm.) N. C. to Ark, and northward. III.
- 9. **A.** conterminum, Willd., var. strigosum, D. C. E. Rootstock stout, erect, often extending a foot above ground, bearing a crown of fronds; stipes very short, narrowly wing-margined at the base; fronds ro-4° long, lanceolate in outline, caudate-acuminate, much narrowed at the base, somewhat rigid, pinnate; pinnæ sessile, narrowly lanceolate from a broader base, acuminate, deeply pinnatifid into oblong, obliquely sub-falcate, obtuse segments, under surface copiously dotted with resinous globules; veins free, simple; sori near the margin; indusium reniform, minute, glandular, somewhat pilose, evanescent. (A. strigosum, Fee, Nephrodium conterminum, Desv. in part.) Fla. VI.
- 10. A. Nevadense,* D. C. Eaton. Rootstock creeping, densely covered with the persistent bases of former stalks; fronds in a crown, 1½°—3° high, lanceolate; pinnæ linear-lanceolate from a broad base, deeply pinnatifid, the lower pairs distant and gradually reduced to mere auricles; segments crowded, oblong, slightly hairy on the veins beneath, and sprinkled with minute resinous particles; veins about seven pairs to a lobe; sori close to the margin; indusium minute, furnished with a few dark colored

marginal glands and bearing several straight jointed hairs on the upper surface. Cal. IV.

- 11. A. Oreopteris, Swz. Rootstock short, erect or decumbent, scaly; stipes short, tufted, scaly below; fronds $1\frac{1}{2}^{\circ}-2^{\circ}$ long, firm membranous, broadly lanceolate, gradually tapering and attenuated below, glandular; pinnæ $2^{\prime}-3^{\prime}$ long, sessile from a broad base, lanceolate-acuminate, deeply pinnatifid, gradually shorter to the lowest which are more distant, deltoid and less than 1^{\prime} long; segments flat, nearly entire, oblong; sori quite marginal; indusia delicate, membranous, more or less toothed at the margin. (Nephrodium Oreopteris, Desv., N. montanum, Baker). Unalaska. IV.
 - †† Lower pinnæ little smaller than those above.
- 12. A. Thelypteris, Swz. (Marsh-fern). Rootstock slender; fronds 1°-2° long, 4′-6′ broad, lanceolate, pinnæ mostly horizontal, linear-lanceolate; segments oblong, entire, obtuse or appearing acute in fruit from the strongly revolute margins; veins mostly forked, bearing the sori near their middle; indusia minute, smooth and naked. (*Polypodium Thelypteris*, L., *Nephrodium Thelypteris*, Desv., *Lastrea Thelypteris*, J. Sm.) Northern U. S. to Fla. III.
- 13. A. patens, Swz. Rootstock rather stout bearing several fronds at the growing end; fronds 2°—3° long, 4′—10′ broad, ovate-oblong, softly pubescent beneath; pinnæ closely placed, linear-acuminate, lowest pair somewhat deflexed, all cut three-fourths of the way to the midrib; segments numerous, acutish, basal ones longest; veinlets evident, lowest ones of adjoining segments often uniting; sori near the margin, indusia very pubescent. (A. molle, Kunze.) Fla. to Cal. VI.
 - ** Texture firmer or sub-coriaceous, veins forking freely.
- † Fronds pinnate; pinnæ cut into spreading triangular lobes; sori confluent.
- 14. A. unitum, R. Br., var. glabrum, Mett. Stipes 1°-1½° long, brownish, naked; fronds 1½° or more long, 5′-8′ broad; pinnæ narrow, cut from one-third to half-way down into sharp pointed lobes; lower pinnæ not reduced; veins pinnate in the broad lobes with 6-8 veinlets on each side, the lower ones of contiguous groups united; sori near the ends of the veins principally in the lobes. Fla. VI.
- †† Fronds bipinnatifid or bipinnate; indusia rather large; segments not spinulose.
 - ‡ Fronds small, narrowly lanceolate.
 - 15. A. fragrans, Swz. Fronds 4'-12' high, glandular and

aromatic; pinnæ linear-oblong, pinnately parted; segments toothed or nearly entire, nearly covered beneath with the very large thin imbricated indusia, which are orbicular with a narrow sinus, the margin ragged and sparingly glanduliferous. (*Nephrodium fragrans*, Rich.) N. Eng., N. Y. to Wis. and northward. II.

‡‡ Fronds larger, mostly 2°-4° high.

- A. Fronds bipinnatifid or nearly twice pinnate; indusia large, thinnish and flat.
- 16. A. Floridanum,* D. C. Eaton. Stipes 6'—10' long, sparingly clothed with ovate scales; fronds 18'—20' long, 5'—8' broad, lanceolate; fertile pinnæ confined to the upper half of the frond, narrowly lanceolate, cut down to the narrowly winged secondary rachises into oblong, distinct pinnæs; the sterile pinnæ broader, shorter and sub-deltoid below, less deeply cut. (A. cristatum, var. Floridanum, Hook., Nephrodium Floridanum, Hook.) Fla. VI.
 - 17. A. cristatum, Swz. Fronds linear-oblong or lanceolate in outline, 1°—2° long; pinnæ short, 2′—3′ long, triangular-oblong or the lowest nearly triangular, deeply pinnatifid; segments 6—10 pairs, finely serrate or cut-toothed; sori as near the midvein as the margin; indusia smooth, naked. (A. Lancastriense, Spreng., Nephrodium cristatum, Michx., Lastrea cristata, Presl.) Canada to Ark. III.
 - Var. Clintonianum,* D. C. Eaton. Fronds much larger, $2\frac{1}{2}$ ° -4° long; pinnæ oblong-lanceolate, broadest at base, $4^{\prime}-6^{\prime}$ long, $1^{\prime}-2^{\prime}$ broad, deeply pinnatifid; segments 8—16 pairs, crowded or distant, linear-oblong, obscurely serrate; veins pinnately forking, bearing the sori near the midvein. N. Eng., N. Y. and westward. III.
 - 18. A. Goldianum,* Hook. Fronds broadly ovate, 2°-4° long; pinnæ 6′-9′ long, broadest in the middle, pinnately parted; the segments about 20 pairs, oblong-linear, sub-falcate, serrate with appressed teeth; veins bearing the sori very near the midvein; indusia very large, orbicular with a narrow sinus. (Nephrodium Goldieanum, Hook., Lastrea Goldieana, J. Sm.) Canada to Ky. III.
 - B. Fronds mostly bipinnate; indusia convex, without marginal guands.
 - 19. A. filix-mas, Swz. (MALE-FERN). Rootstock short, stout; fronds in a crown, 1°-3° high, broadly oblong-lanceolate, slightly narrowed toward the base, bipinnatifid or bipinnate; pinnules oblong, smooth, polished beneath, the larger ones pinnately incised; sori large, near the midvein, commonly on the lower half

or two-thirds of the segment; indusia firm, smooth; rachis more or less chaffy. (*Nephrodium filix-mas*, Rich., *Lastrea filix-mas*, Presl.) Canada to Col., Ariz. and Ore. II.

20. A. marginale,* Swz. Fronds smooth, nearly coriaceous in texture, 6'—2° long, ovate-oblong; pinnæ lanceolate, broadest just above the base; pinnules oblong or oblong-falcate, entire or crenately toothed; sori close to the margin. (Polypodium marginale, L., Nephrodium marginale, Michx., Lastrea marginalis, J. Sm.) Northern U. S. and Canada. III.

††† Fronds bipinnate or tripinnatifid; segments spinulose-toothed.

21. A. rigidum, Swz., var. argutum, D. C. Eaton. Rootstock short, stout; fronds in a crown on chaffy stalks, half-evergreen, smooth above, paler and more or less glandular beneath, 1°—3° high, ovate-lanceolate or triangular-lanceolate, bipinnate; pinnæ broadly oblong-lanceolate, the lowest ones broadest, scarcely shorter than the middle ones; pinnules oblong, incised or doubly serrate with spinulose teeth; indusia firm, convex, the edge bearing short-stalked glands. (A. argutum, Kaulf.) Cal., Ore. IV.

A. spinulosum, Swz. Stipes with a few, pale-brown, deciduous scales; fronds ovate-lanceolate, bipinnate, the pinnæ oblique to the rachis, elongated triangular, the lower pairs broadly triangular; pinnules oblique to the midrib, connected by a very narrow wing, oblong, incised or pinnatifid with lobes spinulose toothed; indusia smooth without marginal glands. (Nephrodium spinulosum, Desv., Lastrea spinulosa, Presl.) Canada and Northern U. S. II.

brown with a darker centre; fronds oblong-ovate, bi—tripinnate; pinnæ spreading, oblong-lanceolate, the lowest unequally triandusium denticulate and beset with stalked glands. (A. intermedium, Willd., A. Americanum, Dav.) Canada to Tenn. II.

4. Var. dilatatum, Horneman. Scales of the stipes large, brown with a darker centre; fronds broadly ovate or triangular-ovate, pftenest tripinnate; pinnules lance-oblong, the lowest often much elongated; indusia smooth and naked. (A. dilatatum, Swz. A. campylopterum, Kunze., Nephrodium dilatatum, Desv., Lastrea dilatata, J. Sm. A dwarf form is var. dumetorum.) Canada and N. E. to Ore. II.

23. A. Boottii, Tuckerman. Scales of the stipes pale brown; fronds elongated oblong or elongated lanceolate in outline; pinnules broadly oblong, very obtuse, the lower pinnatifid, the upper

and smaller merely serrate; indusia minutely glandular. (A. spinulosum, var. Boottii, Gray.) N. Eng., N. Y. and northward. II.

XXI. NEPHROLEPIS, Schott.

Sori round, arising from the apex of the upper branch of a vein, usually near the margin. Indusia reniform or roundish. Veins all free, the fronds simply pinnate, the pinnæ articulated at the base, and bearing white cretaceous dots on the upper surface. Name from Gr. nephros, a kidney, and lepis, a scale. A tropical and sub-tropical genus containing seven species.

1. N. exaltata, Schott. Stipes tufted, 4'-6' long, naked or slightly scaly; fronds $1^{\circ}-6^{\circ}$ long, 3'-6' broad; pinnæ close, lanceolate, the edge entire or slightly crenate, the upper side auricled at the base, the lower rounded; rachis nearly naked; sori submarginal; indusia firm, distinctly reniform. Fla. VI.

XXII. CYSTOPTERIS, Bernh. BLADDER-FERN.

Sori roundish, borne on the back of the veins. Indusium delicate, hood-like, or arched, attached by a broad base on the inner side partly under the sorus, early opening, free at the other side, and thrown back or withering away. Veins free. Name from Gr. kustis, a bladder, and pteris, a fern, alluding to the inflated indusia. Found in the temperate zones of both hemispheres; contains five species.

- * Fronds ovate-lanceolate, bi-tripinnate.
- 1. C. bulbifera,* Bernh. Stipes 4'-6' long; fronds lanceolate, elongated, 1°-2° long, bi-tripinnatifid, pinnæ lanceolate-oblong; pinnules crowded, toothed or pinnatifid; rachis wingless often bearing bulblets underneath; indusia short truncate on the free side. (Aspidium bulbiferum, Swz., Nephrodium bulbiferum, Michx.) N. Eng. to Va. and N. C. III.
- 2. C. fragilis, Bernh. Fronds oblong-lanceolate, 4'—8' long, I'—2½' broad, bi—tripinnate; pinnæ and pinnules lanceolate or ovate in outline, decurrent along the margined or winged rachis; indusia tapering or acute at the free end. Narrower, less divided specimens, barely bipinnate with obtuse and bluntly toothed pinnules form the var. dentata, Hook. Like many other so-called varieties it passes insensibly into the typical form. (Aspidium tenue, Swz.) N. Eng. to Cal. and northward. II.
 - ** Fronds deltoid-ovate, tri-quadripinnate.
- 3. C. montana, Bernh. Rootstalk long, slender, creeping; stipes 6'—9' long, slender; fronds about 6' each way; lowest pinnæ deltoid-lanceolate, much larger than those above, their

inferior pinnules 1'-11/2' long; segments cut to the rachis into oblong lobes, deeply and sharply toothed; sori numerous. Col., L. Superior and northward. II.

XXIII. ONOCLEA, L.

Sori round, borne on the back of the veins of the contracted fertile frond, and quite concealed by their revolute margins. Indusium very thin membranous, hemispherical or hood-like, fixed at the inferior side of the sorus. Fr onds conspicuously dimorphous. Name from Gr. onos, a vessel, and kleiein, to close, alluding to the fertile fronds. A cold temperate genus containing three species.

EUONOCLEA. Veins of sterile frond copiously anastomosing.

sensibilis, L. (SENSITIVE-FERN.) Fertile fronds bipinnate, much contracted; pinnules short, usually rolled up and converted into berry-shaped closed involucres, and forming a one sided panicle; sterile fronds broadly triangular, deeply pinnatifid into lanceolate-oblong pinnæ, which are entire, undulate, or the lowest pair sinuate pinnatifid: veins copiously anastomosing. In var. obtusilobata, Torr., the sterile fronds are again pinnatifid, more or less contracted and revolute, and bear a few sori. N. Eng. to Fla. and Kan. III.

STRUTHIOPTERIS, Willd. Veins all free.

3,1884. O. Struthiopteris, Hoffm. (OSTRICH-FERN.) Fertile fronds 1°-1½° long, simply pinnate with necklace-shaped pinnæ formed of the strongly revolute margins; sterile fronds 2°-6° long, grow-Ang in a crown, broadly lanceolate, bipinnatifid, the lowest pinnæ gradually much shorter; veins pinnate, free and simple; sori crowded and confluent. Sterile fronds sometimes partially contracted and bearing sori analogous to var. obtusilobata above. (O. Germanica, Willd., O. nodulosa, Michx., Struthiopteris Pennsylvanica, Willd., S. Germanica, Willd., Osmunda Struthiopteris, L.) N. Eng. to Ill. II.

XXIV. WOODSIA, R. Br.

Sori round, borne on the back of simply-forked free veins. Indusium inferior, thin and often evanescent, either small and open, or early bursting at the top into irregular pieces or lobes. Named for Joseph Woods, an English botanist. A genus of high temperate or boreal latitudes including 15 species.

& I. EUWOODSIA. Indusium minute or evanescent, open and flat from an early stage, concealed under the sorus, its margin cleft into slender hairs or cilia.

* Stipes obscurely jointed near the base; cilia of the indusium long, inflexed over the sporangia.

† Fronds thickly clothed underneath with rusty bristle-like chaff.

N. Ilvensis, R. Br. Fronds broadly lanceolate, smoothish above, pinnate; pinnæ crowded, sessile, pinnately-parted, the crowded segments oblong, obscurely crenate; sori near the margin, somewhat confluent when old. (W. rufidula, Beck., Acrostichum Ilvense, L., Polypodium Ilvense, Swz., Nephrodium rufidulum, Michx., Aspidium rufidulum, Willd.) Va. to Ky. westward and northward. II.

†† Fronds glabrous or nearly so.

- 2. W. hyperborea, R. Br. Stipes and rachis sometimes slightly hairy; fronds linear-lanceolate, pinnate; pinnæ cordato-ovate, pinnatifid with few (5—7) broadly obovate entire lobes. Vt., N. Y. and northwestward. II.
- 3. W. glabella, R. Br. Smooth and naked throughout; fronds linear, tapering slightly below, 2'—5' high, pinnate; pinnæ deltoid or ovate, the lower rather remote, cut into 3—7 rounded or subcuneate entire lobes. Vt., N. Y. and northward. II.
- ** Stipes not jointed; cilia of the indusium very short, hidden by the sporangia.
- 4. W. scopulina,* D. C. Eaton. Rootstock short, creeping, very chaffy; stipes 2'-4' long, puberulent like the rachis and under surface of the frond with minute flattened hairs and stalked glands; fronds lanceolate, 4'-8' long, pinnate; pinnæ numerous, oblong-ovate, pinnatifid with 10-16 short ovate or oblong toothed divisions; indusia very delicate, deeply cleft into laciniæ which terminate in short hairs. Col., Ariz., Cal., Ore. and northward. IV. W. Oregana,* D. C. Eaton. Stipes and fronds smooth; fertile fronds taller than the sterile ones; pinnæ triangular-oblong, pinnatifid; segments oblong or ovate, toothed or crenate; teeth often reflexed and covering the submarginal sori; indusia very minute, divided almost to the centre into a few beaded hairs. Ariz., Utah, Col., Ore. and northward. II.
 - 6. W. Mexicana, Fee. Stipes 2'—3' long, smoothish or with a few scattered scales; fronds 3'—9' long, lanceolate; pinnæ subopposite, triangular-lanceolate, pinnately divided into finelytoothed segments, the teeth in young fronds ending in delicate, semi-transparent, ciliated tips; sori near the margin, broad, confluent; receptacles dot-like, scales of indusium four, laciniate, narrow, dividing at the end into articulated hairs; sporangia nearly sessile. Ariz., N. Mex. V.

chief

- § 2. Hypopeltis, Torr. Indusium conspicuous, at first enstrosing the sporangium, but early opening at the top and splitting into several spreading jagged lobes.
 - 7. W. obtusa, Torr. Stipes not jointed, 3'-6' long; fronds broadly lanceolate, minutely glandular-hairy, 6'-12' high, nearly bipinnate; pinnæ rather remote, triangular-ovate or oblong, pinnately parted; segments oblong, obtuse, crenately toothed, the lower ones pinnatifid; veins forked. (W. Perriniana, H. & G., Aspidium obtusum, Willd., Cheilanthes crenata, Kunze., Hypopeltis obtusa, Torr.) N. Eng. to Ky., Kan, and Ariz. III.

W. Plummeræ, Lemmon, is based on some form of No. 7.

XXV. DICKSONIA, L'Her.

Sori small, globular, marginal or intra-marginal. Sporangia borne in an elevated, globular receptacle, enclosed in a membranous, cup-shaped indusium, which is open at the top, and on the outer side partly adherent to a reflexed toothlet of the frond. Named for *James Dickson*, an English botanist, 1738—1822. Includes 44 species, more than half of which are arborescent.

- § Sitoloвium, J. Sm.
- 1. D. pilosiuscula,* Willd. Rootstock slender, extensively creeping, naked; stipes stout, chaffless; fronds 1°-2½° long, 5′-9′ broad, ovate-lanceolate and pointed, usually tripinnatifid; pinnæ lanceolate, pointed; pinnules cut into oblong and obtuse cuttoothed lobes; rachis and under surface minutely glandular and hairy; sori minute, each on a recurved toothlet, usually one at the upper margin of each lobe. (D. punctiloba, Hook., D. punctilobula, Kunze and former Ed., Nephrodrum punctilobulum, Michx., Aspidium punctilobulum, Torr.) Can. to Tenn. III.

XXVI. TRICHOMANES, Sm. FILMY-FERN.

Sori marginal, terminating a vein, more or less sunken in the frond. Sporangia sessile on the lower part of a cylindrical, filiform, often elongated receptacle. Indusia tubular or funnel-shaped, entire or two-lipped at the mouth. Fronds delicate, pellucid. Name from Gr. trichomanes, the name of some fern, from thrix, hair, and mainomai, producing frenzy, alluding to some supposed property. A tropical and temperate genus containing 91 species.

- 8 EUTRICHOMANES.
- 1. T. Petersii,* Gray. Stipes 1"-2" long; fronds 3"-10" long, 1"-2" broad, oblong-lanceolate or obovate, entire or variously pinnatifid, the younger ones with a few black hairs along

the margins; indusium solitary, terminal, funnel-shaped, the mouth expanded and slightly two-lipped, the receptacle included. Ala., Fla. VI.

2. T. radicans, Swz. Rootstock wiry, tomentose; stipes ascending, 1'-3' long, naked or nearly so, usually broadly winged; fronds 2'-8' long, $1'-1\frac{1}{2}'$ wide, lanceolate or ovate-lanceolate, bipinnatifid; pinnæ ovate, obtuse, the upper side of the base parallel and appressed to the winged rachis, the lower side cuneate; divisions toothed or divided into linear lobes; indusia terminal on short lobes, tubular or funnel-shaped, the mouth slightly two-lipped; receptacle exserted little or very much. (T. speciosum, Willd.) Ala., Tenn., Ky. VI.

XXVII. LYGODIUM, Swz. CLIMBING-FERN.

Sporangia ovoid, solitary or occasionally in pairs, in the axils of large imbricated scale-like indusia, which are fixed by their broad bases to short oblique veinlets. Fronds scandent, twining, bearing stalked and variously lobed divisions in pairs. Veins mostly free. Name from Gr. *lugodes*, flexible, alluding to the scandent stems. Includes 16 species.

& EULYGODIUM.

1. L. palmatum,* Swz. Stipes slender, flexile and twining; fronds 1°-3° long, the short alternate branches or petioles 2-forked, each fork bearing a round-cordate palmately 4-7 lobed pinnule; fertile pinnules above, contracted, several times forked, forming a terminal panicle; surfaces naked; texture thinly herbaceous. (Hydroglossum palmatum, Willd.) Mass. and N. Y. to Ky. and Fla. III.

XXVIII. ANEIMIA, Swz.

Sporangia ovate, sessile, placed in two rows on the back of the very narrow branchets of the two long-stalked, panicled, lower branches of a pinnately divided frond, the fertile branches in a few species entirely distinct from the sterile frond. Veins free or anastomosing. Name from Gr. anaimia, bloodless. A small genus chiefly from tropical America, containing 27 species.

& EUANEIMIA.

1. A. adiantifolia, Swz. Rootstock creeping; stipes 1°-1½° long, firm, naked; fronds sparingly pubescent, the two lower branches elongated, pinnately decompound, fertile; sterile portion deltoid-ovate, bi—tripinnate; ultimate segments obovate or cuneate, entire or lobed, striate above with numerous flabellate veins. Fla. VI.

2. A. Mexicana, Klotzsch. Rootstock creeping, covered with narrow blackish chaff; stipes slender, scattered, 6'—12' long; the two lower branches of the frond fertile, long-stalked, glandular, bipinnate with densely clustered fructification; the rest of the frond like the sterile ones, deltoid-ovate, simply pinnate; pinnæ about six pairs and a rather large terminal one, short-stalked, ovate-lanceolate, subcoriaceous, smooth and somewhat glossy; midrib distinct, veins free, oblique, parallel, closely placed, once or twice forked. Western Tex. V.

XXIX. SCHIZÆA, Sm.

Sporangia large, ovoid, striate rayed at the apex, naked, vertically sessile in a double row along the single vein of the narrow divisions of the fertile appendages to the slender and simply linear, fan-shaped, or dichotomously many cleft fronds. Name from Gr. schizein, to split, alluding to the forked sterile fronds of foreign species. Includes 16 species.

& Euschizæa.

1. S. pusilla,* Pursh. Sterile fronds linear, very slender, flattened and tortuous; fertile ones equally slender, 3'-4' high, and bearing at top the fertile appendage consisting of about five pairs of crowded pinnæ, forming a distichous spike. N. J., N. S., Newfoundland (?). III.

XXX. OSMUNDA, L. FLOWERING-FERN.

Fertile fronds or fertile portions very much contracted, bearing short pedicelled, naked sporangia on the margin of the rachislike divisions. Sporangia globular, large, opening by a longitudinal cleft into two halves, bearing near the apex a few parallel striæ, the rudiment of a transverse ring. Spores green. Named for Osmunder, a Saxon name for the divinity Thor. A genus containing six species mostly north temperate.

* Fronds bipinnate, fertile at the apex.

1. 6. regalis, L. Stipes tufted, 1°-1½° long, erect, naked; fronds 2°-4° long, 1° or more broad; sterile pinnæ 6′-12′ long, 2′-4′ broad; pinnules oblong-oval to lance-oblong, sessile or slightly stalked; the fertile pinnules cylindrical, panicled; texture sub-coriaceous; rachis and both sides naked. (O. spectabilis, Willd., O. glaucescens, Link.) Canada to Fla. and Miss. III.

** Sterile fronds bipinnatifid.

2. O. Claytoniana, L. Stipes tufted, 1° or more long, clothed with loose woolly tomentum when young, naked when mature; fronds 1°-2° long, 8'-12' broad; pinnæ oblong-lanceolate with

oblong, obtuse divisions; 2—5 pairs of central pinnæ fertile; fertile pinnules dense, cylindrical; texture herbaceous. (O. interrupta, Michx.) Canada to Ky. and northward. III.

3. O. cinnamomea, L. (CINNAMON-FERN.) Stipes densely tufted, 1° or more long, the sterile and fertile fronds distinct; clothed when young with ferruginous tomentum; sterile fronds smooth when mature, the pinnæ lanceolate, cut into broadly oblong, obtuse divisions; fertile fronds contracted, bipinnate, with cinnamon-colored sporangia. In var. frondosa, Gray, some of the fronds are sterile below and sparsely fertile at the summit. (O. Claytoniana, Conrad.) N. Eng. and Wis. to Fla. III.

ORDER IV. MARSILIACEÆ, R. Br.

· Perennial plants rooted in mud, with a slender creeping rootstock and either filiform or 4-parted, long-petioled leaves. Fructification consisting of sporocarps borne on peduncles, which rise from the rootstock near the leaf stalk or consolidated with it and containing both macrospores and microspores. Consisting of two genera both found in this country.

- I. Marsilia, L. Sporocarps ovoid; leaves quadrifoliate.
- II. Pilularia, L. Sporocarps globose; leaves filiform.

I. MARSILIA, L.

Sporocarps ovoid or bean-shaped, composed of two vertical valves having several transverse compartments or sori in each valve, the sori composed of both macrosporangia and microsporangia. Sporocarps also provided with a ring which at the opening of the valves swells and tears the sori from their position. Leaves quadrifoliate on slender petioles; the sporocarps peduncled and rising from the petiole or from the rootstock at the base of the petiole. Named for *Aloysius Marsili*, an early Italian naturalist. Contains about 50 species, six occurring within our limits.

- * Leaflets more or less hairy.
- † Peduncles scarcely half the length of the sporocarps; leaflets narrow.
- r. M. tenuifolia, Engelm. Leaflets obliquely lanceolate, truncate at the apex, unequally toothed, sparsely appressed-hairy; sporocarps single, ascending, obliquely-obovate, laterally compressed, the upper margin scarcely convex; raphe short; teeth approximate, the upper scarcely more prominent than the lower; paleæ short, appressed, scattered; sori 9—10 to each valve. W. Tex.
 - †† Peduncles nearly as long as sporocarps; leaflets broader.

- 2. M. vestita, H. & G. Leaflets entire, covered with paleaceous brown hairs; sporocarp single, ascending, oval, somewhat compressed; raphe short, terminating in two approximate teeth, the lower short and blunt, the upper acute, a little larger, hardly curved; paleæ long, dense, somewhat spreading; sori 7—8 on each valve. Ia., Tex., Cal., Ore.
- 3. M. mucronata, A. Br. Leaflets spatulate, entire, slightly hairy; sporocarps single, borne on ascending peduncles, nearly horizontal, obliquely oval, slightly compressed, carinate below, truncate behind; raphe short, terminating in two approximate teeth, the upper longer and straight or slightly curved at the point; stomata of sporocarps large and purple; paleæ compressed, indistinct; sori 8—9 on each valve. Hardly distinct from the preceding. Tex.

††† Peduncles 2-4 times the length of the sporocarps.

- 4. M. uncinata, A. Br. Leaflets narrow at base, fan-shaped, entire, sparsely hairy; sporocarps single, borne on erect peduncles, horizontal, short-oval or suborbicular, considerably compressed, truncate behind; raphe long, terminating in two approximate teeth, the upper longer, and uncinately curved; stomata of sporocarps large and purple; sori 13—14 on each valve. Ark., N. Mex.
- 5. M. macropoda, Engelm. Leaflets fan-shaped, undulate, entire at apex, white-hairy on both sides; sporocarps 2—5, on erect, branching peduncles, ascending, obliquely hatchet-shaped, narrowed toward the base, the upper margin less convex than the lower, laterally compressed; raphe short, the lower tooth obtuse, the upper almost wanting; paleæ narrow, persistent; sori ten on each valve. Tex.

** Leaflets glabrous.

6. M. quadrifolia, L. Leaflets broadly obovate-cuneate; sporocarps usually 2—3 on a short peduncle, which arises from near the base of the petioles, glabrous or somewhat hairy. Bantam Lake, Ct., Charles R., Mass.; also introduced into other New England ponds.

II. PILULARIA, L.

Sporocarps globose, longitudinally 2—4 celled, dehiscent from the apex; cells with parietal cushions bearing in the upper portion microsporangia and below these, numerous sporangia containing solitary macrospores. Leaves filiform from a slender creeping rootstalk, the sporocarps subsessile or peduncled on the rhizome or in the axils of the leaves. Named from Lat. pilus, hair. Includes five species widely distributed.

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1. P. Americana, A. Br. Leaves setiform, 1' long; sporocarps 1" in diameter, attached by the side to a short, descending peduncle, usually 3-celled; macrospores 13—17 in each cell, not constricted in the middle. Ark., Cal.

ORDER V. SALVINIACEÆ.

Floating plants with a more or less elongated and sometimes branching axis bearing apparently distichous leaves. Sporocarps soft, thin-walled, two or more on a common stalk, 1-celled, with a central, often branched receptacle which bears macrosporangia containing a single macrospore, or microsporangia containing numerous microspores. Consisting of two genera, only one within our limits.

I. AZOLLA, Lam.

Small, moss-like plants with pinnately branched stems covered with minute, imbricated, 2-lobed leaves, and emitting rootlets beneath. Sporocarps in pairs beneath the stem, either both containing macrospores, or one of each kind. Smaller sporocarps acorn-shaped, containing a single macrospore at the base. Larger sporocarps globose, producing from the base many pedicelled sporangia, containing several masses of microspores. Named from Gr. azein, to dry, and ollunai, to destroy. Includes four species.

1. A. Caroliniana, Willd. Plant 4"—12" broad, much branched; leaves with ovate lobes, the lower reddish, the upper green with a reddish border; macrospores with a minutely granulate surface; masses of microspores barbed at the tip. (A. microphylla, Kaulf.) N. Y. to Fla., Ariz. and Ore.

ORDER VI. LYCOPODIACEÆ, Lindl.

Moss-like, terrestrial plants with small, lanceolate or subulate, sometimes oblong or roundish, simple leaves, arranged in two to many ranks on trailing or sometimes erect, usually branching stems. Sporangia 1-3-celled, solitary in the axils or the leaves or on their upper surface. Spores of one kind, minute. Prothallium (so far as known) subterranean, without chlorophyll. Contains four genera, the following within our limits.

- I. Lycopodium, L. Leaves apparent, in 4—many ranks. Sporangia 1-celled.
- II. Psilotum, R. Br. Leaves minute, abortive. Sporangia 3-celled.

I. LYCOPODIUM, L. CLUB-MOSS.

Perennial, terrestrial plants, with evergreen, one-nerved leaves arranged in 4—16 ranks. Sporangia coriaceous, flattened, reniform, one-celled, opening transversely, situated in the axils of ordinary leaves, or with fruit-bearing leaves modified into bracts which are arranged in spikes either sessile or peduncled. Spores copious, minute, sulphur-colored, inflammable. Named from Gr. lukos, wolf, and pous, foot, without obvious application. Contains about 105 species.

- § 1. Plananthus, Beauv. Sporangia borne in the axils of leaves which are similar to those of the sterile and fertile stems.
- * Sporangia usually wanting in axils of upper leaves; leaves dark-green, shining, about 8-ranked.
- 1. L. Selago, L. Stems 3'-6' high, thick, rigid, erect, 2-3 times forked forming a level-topped cluster; leaves elongate-lanceolate, mucronulate, entire or spinulose-denticulate, nerved above, convex below. (*L. recurvum*, Kit., *L. suberectum*, Lowe, *Plananthus Selago*, Beauv.) Mts. of N. C. to N. Eng. and Mich. and northward to Alaska and Greenland.
- 2. L. lucidulum, Michx. Stems ascending, thick, 2-3 times forked, the branches 6'—12' high; leaves widely spreading or reflexed, flat, one-nerved, acute, minutely toothed. (*L. reflexum*, Swz., *L. serratum*, Desv., *Plananthus reflexus*, Beauv.) N. C. and northward.
- ** Sporangia only in axils of upper leaves which form spikes; leaves many-ranked.
- 3. L. inundatum, L. Sterile stems creeping, flaccid, forking; fertile stems erect, simple, t'-4' high, bearing a short, thick spike; leaves lanceolate or lance awl-shaped, acute, entire, soft, spreading or curved upward on prostrate stems. (L. palustre, Lam., Plananthus inundatus, Beauv.) Forms having the fertile stems 5'-7' high, with more pointed, often tooth-bearing leaves are the var. Bigelovii, Tuckerm. (L. Carolinianum, Bigel.) N. Eng. to Mich. and southward.

Var. pinnatum, Chapm. Stems pinnately branched; leaves bristly-fringed below the middle, unequal, the upper and lower shorter and somewhat appressed, the lateral widely spreading; fertile stems 1° high, very leafy; spike thick, cylindrical, 2′—3′ long. W. Fla.

4. L. alopecuroides, L. Stems stout, densely leafy throughout; sterile branches flaccid, procumbent, creeping; fertile

branches rigid, erect, 6'—20' high, bearing a single spike: leaves narrowly linear-awl-shaped, spinulose-pointed, spreading, conspicuously bristle-toothed below the middle, nerved above, those of the cylindrical spike with long, setaceous tips. (L. longipes, H. & G., Plananthus alopecuroides, Beauv.) N. J. to Fla. and Miss.

§ 2. EULYCOPODIUM. (LEPIDOTIS, Beauv.) Sporangia borne in the axils of yellowish, scale-like, imbricated, ovate or cordate leaves which form a distinct spike; leaves of sterile branches very unlike those of the spikes.

* Stems leafy to base of spikes or nearly so. † Spikes nodding.

5. L. cernuum, L. Stems erect, branching, the branches similar; leaves crowded, awl-shaped, incurved, terete in the middle, spreading, grooved below; bracts 8-ranked. (L. marianum, Willd., L. curvatum, Blume., L. Boryanum, Richard, L. bryifolium, Vent.) Fla., S. Ala.

†† Spikes erect, closely sessile.

- 6. L. annotinum, L. Stems much branched, prostrate, creeping, r°—4° long; the ascending branches similar, 5′—8′ high, sparingly forked; leaves equal, spreading, five-ranked, rigid, linear-lanceolate, minutely serrulate, nerved below; spike oblong, cylindric, thick. (L. juniperifolium, Lam., L. bryophyllum, Presl, Lepidotis annotina, Beauv.) Mountain forms with shorter and more rigid, pointed leaves are var. pungens, Desv. (L. reclinatum, Michx.) N. Eng, and N. J. to W. T. and northward to Alaska and Greenland.
- 7. L. dendroideum, Michx. (GROUND-PINE.) Stems erect, 6'—9' high, from a subterranean creeping rootstock, densely branched above, the crowded branches spreading fan-like; leaves 4—6 ranked, lanceolate-linear, acute, entire; spikes 4—10 on each plant; bracts many-rowed. (*Lepidotis dendroidea*, Beauv.) Forms with the stems appearing flat, from the leaves of the upper side being shorter and appressed are the var. obscurum, (L. obscurum, L.) Mts. of N. C. to Can. and northwestward to Ind., Mich. and Western N. America.
- 8. L. alpinum, L. Stems elongated, creeping, with ascending densely clustered branches; leaves 4-ranked, erect, imbricated, adnate-decurrent, of two forms; those of the lateral rows lanceolate, falcate, acute, carinate, concave within; those of the intermediate rows scarcely one-third smaller, lance-awl-shaped, the upper and lower rows not different. (Possibly a form of L. complanatum, L.) L. Superior to Rocky Mts. and Unalaska.

††† Spikes erect, short-peduncled.

- 9. L. sabinæfolium, Willd. (GROUND-FIR.) Stems elongated, creeping, usually underground; branches erect, short, dichotomous, clustered; leaves 4-rowed, small, appressed, lanceolate, mucronate, entire, apparently terete; spikes cylindric, solitary, with cordate acuminate bracts. (L. alpinum, Michx., L. armatum, Desv.) N. J., N. Y., N. Eng. and northwestward.
- ** Fertile branches with minute leaves so that the spikes appear long-peduncled.
 - † Leaves uniform, many ranked; stems terete.
- ro. L. clavatum, L. (Running-pine.) Stems extensively creeping; branches similar, ascending, short and leafy, the fertile terminated by a slender peduncle bearing 1—4 linear, cylindric spikes; leaves much-crowded, linear-awl-shaped, tipped like the bracts with a fine bristle. (L. officinale, Neck., L. vulgare, Vaill., L. inflexum, Swz., L. serpens, Presl, Lepidotis inflexa, Beauv.) N. C. to Canada and westward to W. T. and Unalaska.
 - †† Leaves of two forms, few ranked; stems flattened.
- 11. L. Carolinianum, L. Sterile stems and their few short branches entirely creeping; lateral leaves broadly lanceolate, acute, and somewhat oblique, one-nerved, widely spreading in 2-ranks; upper row of leaves shorter, appressed; peduncle simple, slender, 2'—4' high, clothed with small bract-like leaves, bearing a single cylindric spike. (L. repens, Swz., L. affine, Bory., Lepidotis repens, Beauv.) N. J. to Fla., Ala. and La.
- 12. L. complanatum, L. Stems extensively creeping, with erect or ascending fan-like branches several times forked above; branchlets crowded, flattened; leaves minute, imbricated-appressed, 4-ranked; the lateral rows with somewhat spreading tips; the intermediate smaller, narrower, and wholly appressed; peduncle slender, bearing 2-4 cylindric spikes. (L. thyoides, Humb. & Bonpl., L. tristachyon, Pursh, L. anceps, Wallr. L. chamæcyparissus, A. Br., Lepidotis complanata, Beauv.) N. C. to N. Eng., Mich. and northward.

II. PSILOTUM, R. Br.

Perennial plants, terrestrial or growing on trees. Stems dichotomously-branched with minute alternate leaves or apparently leafless. Sporangia sessile, 3-celled, opening at the apex into 2—3 valves. Spores farinaceous, oval or elongate-reniform. Name from Gr. psilos, naked, alluding to the abortive leaves. Contains four species mostly tropical.

1. P. triquetrum, Swz. Stems erect, 8'—10' high, triquetrous at base, many times forked at apex; ultimate divisions triquetrouswinged; leaves remote, awl-shaped, less than 1" long; sporangia in spikes. (P. Floridanum, Michx., P. dichotomum, Link, Bernhardia dichotoma, Willd., B. pedunculata, Desv., Lycopodium nudum, L.) E. Fla.

ORDER VII. SELAGINELLACEÆ.

Leafy, terrestrial, moss-like plants with branching stems and minute scale-like leaves. Sporangia one-celled, solitary, axillary, some containing microspores and others macrospores. Contains a single genus.

I. SELAGINELLA, Beauv.

Fructification arranged in spikes. Sporangia minute, subglobose, opening transversely; some containing usually 4 globose macrospores, and others smaller, filled with numerous microspores. Leaves 4—many ranked. Name a diminutive of Selago, an ancient name of some species of Lycopodium which this genus resembles. Contains about 200 species widely distributed but largely tropical.

- * Leaves of one kind, many-ranked.
- † Stems prostrate or spreading, somewhat rigid.
- 1. S. rupestris, Spring. Stems prostrate or ascending, muchbranched, 2'—12' long; leaves appressed-imbricated, lanceolate, convex with a grooved keel, bristle-tipped, ciliate; spikes strongly quadrangular; sporangia of both sorts in the same axils; macrosporangia abundant. (Lycopodium rupestre, L., L. bryopteris, Wall.) N. E. to Fla., Tex., Cal. and northward.
- 2. S. tortipila, A. Br. Leaves sub-entire, gibbous dorsally near the apex; terminal bracts tipped with a long, twisted, white awn; macrospores loosely reticulated. (Near S. rupestris, possibly only a variety.) N. C., S. C.
- 3. S. selaginoides, Link. Sterile stems prostrate or creeping, small and slender; fertile stems thicker, ascending, simple, 1'-3' high; leaves lanceolate, acute, spreading, sparsely spinulose-ciliate. (S. spinosa, Beauv., Lycopodium selaginoides, L., L. ciliatum, Lam.) N. H. to Col. and northward to Greenland.

†† Stems pendent, flaccid.

4. S. Oregana, D. C. Eaton. Stems 1°—6° long, pinnately much branched; leaves loosely imbricated, scarcely 1" long, linear-lanceolate, convex and grooved on the back, acute, sparsely

spinulose-denticulate, not bristle-tipped; spikes very slender; macrosporangia scarce. Cal., Ore.

** Leaves of two forms, 4-ranked.

- † Stems and branches rolling into a nest-like ball when dry.
- 5. S. lepidophylla, Spring. (RESURRECTION-PLANT.) Stems numerous, decumbent, very leafy, disposed in a spiral, 2—3 pinnate; leaves closely imbricated, the lateral ovate, obtuse, somewhat scarious-margined, ciliolate at base, the intermediate rows scarcely smaller, ciliolate, blunt divergent. (Lycopodium lepidophyllum, H. & G., L. circinale, Mart. and Gale., L. nidiforme, Herb.) Ariz.

†† Stems remaining flat when dry.

- 6. S. apus, Spring. Stems tufted, prostrate, creeping, much branched, flaccid; leaves membranous, the larger spreading horizontally, ovate, oblique, mostly obtuse, the smaller appressed, taper-pointed; those of the short spike nearly similar; macrosporangia copious at the lower part of the spike. (*Lycopodium apodum*, L., *L. albidulum*, H. & G.) N. E. to Rocky Mts. and southward to Fla. and Tex.
- 7. S. Douglasii, Spring. Stems decumbent, $6'-2^{\circ}$ long; branches 4'-6' long, bi—tripinnately divided; lateral leaves 1'' long, obliquely oval, obtuse, faintly nerved; upper leaves 1'' long, oval, incurved, ending in a short point; both kinds sparingly ciliate at base; spikes terminal, quadrangular. (Lycopodium Douglasii, H. & G., L. ovalifolium, H. & G.) Cal. to Br. Col.

ORDER VIII. ISOETACEÆ.

Grass-like or rush-like-plants, submerged, amphibious or some growing in moist soil. Sporangia sessile in the axils of the leaves, some containing macrospores and others microspores. Contains a single genus.

I. ISOETES, L. QUILLWORT.

Stem or trunk a more or less depressed, fleshy corm, rooting just above its bilobed (in foreign species trilobed) base, covered above with the dilated and imbricated bases of the awl-shaped or linear leaves. Sporangia large, orbicular or ovoid, plano-convex, very thin, sessile in the axils of the leaves and united at the back with their excavated bases; those of the outer leaves filled with spherical macrospores; those of the inner leaves filled with minute and powdery, grayish, obliquely oblong and triangular microspores. Name from Gr. *isos*, equal, and *etos*, year. Contains about 50 species widely distributed.

Note. - The measurements of the spores are given in millimetres, mm. = .03937 inch.

- § 1. Submerged, rarely above water in driest seasons; leaves quadrangular without peripheral bast-bundles; velum incomplete.

 * Stomata absent.
- 1. Iacustris, L. Leaves 10-25, stout, rather rigid, obtusely quadrangular, acute but scarcely tapering, dark or olive-green, 2'-6' long; sporangia orbicular—broadly-elliptical, with a narrow velum; ligula triangular, short or somewhat elongated; macrospores 0.50—0.80 mm. in diameter, marked all over with distinct or somewhat confluent crests; microspores smooth, 0.035—0.046 mm. long. N. Eng. to L. Superior. Var. paupercula, Engelm., has fewer, thinner and shorter leaves and smaller spores, the microspores somewhat granulated, 0.026—0.036 mm. long. Col., Cal.
- 2. I. pygmæa, Engelm. Leaves 5—10, stout, rigid, bright green, ½'—1' long, abruptly tapering to a fine point, with very short epidermis cells; sporangia orbicular with a narrow velum; macrospores 0.36—0.50 mm. thick, marked with minute, rather regular, distinct or rarely confluent warts; microspores brown, almost smooth, 0.024—0.029 mm. long. Cal.
- 3. I. Tuckermani, A. Br. Leaves 10—30, very slender, tapering, olive-green, 2'—3' long, the outer recurved; sporangia mostly oblong, white or rarely brown spotted, the upper third covered by the velum; macrospores 0.44—0.56 mm. thick, the upper segments marked with prominent, somewhat parallel and branching ridges, the lower half reticulate; microspores smooth or nearly so, 0.026—0.032 mm. long. Mass.

** Stomata present.

4. I. echinospora, Durieu, var. Braunii, Engelm. Leaves 13—15, erect or spreading, tapering, green or reddish-green, 3'—6' long, generally with few stomata toward the tip only; sporangia orbicular—broadly-elliptical, spotted, ½ to ¾ covered by the velum; macrospores o 40—0.50 mm. thick, covered with broad, retuse spinules, sometimes somewhat confluent and then dentate and incised at the top; microspores 0.026—0.030 mm. long, smooth. (I. Braunii, Durieu.) N. Eng. and N. J. to Mich. and Utah, and northward to Greenland.

Var. robusta, Engelm. Stouter; leaves 25—70, 5'—8' long, with abundant stomata all over their surface; velum covering one-half of the large, spotted sporangia; macrospores 0.36—0.55 mm. thick. Lake Champlain.

Var. Boottii, Engelm. Leaves 12—20, erect, soft, bright green, 4'—5' long, with few stomata mostly near the tip; sporangia nearly orbicular, pale-spotted, 2% or more covered by the broad velum;

macrospores 0.39—0.50 mm. thick, with longer, more slender and delicate, generally simple spinules; microspores 0.026—0.030 mm. long. (*I. Boottii*, A. Br.) Mass.

Var. muricata, Engelm. Leaves 15—20, flaccid, bright green, 6'—12' long, with very few stomata; sporangia broadly oval, pale spotted, about half covered by the velum; macrospores 0.40—0.58 mm. thick, with shorter and more confluent, sometimes almost crest-like spinules; microspores 0.028—0.032 mm. long, slightly rough on the edge. (I. muricata, Durieu.) Mass.

- 5. I. Bolanderi, Engelm. Leaves 5—25, erect, soft, bright green, tapering to a fine point, 2'—4½' long, with thin walls and generally few stomata; sporangia broadly oblong, mostly unspotted, with a narrow velum; ligula triangular; macrospores 0.30—0.45 mm. thick, marked with minute low tubercles, rarely confluent into wrinkles; microspores deep brown, 0.026—0.031 mm. long, spinulose, rarely smooth. (I. Californica, Engelm.) Utah to Cal. and W. T.
 - ¿ 2. Amphibious, partially emerged; stomata always present.* Peripheral bast-bundles absent.

† Velum partial.

- 6. I. saccharata, Engelm. Trunk usually flat, depressed; leaves 10—20, awl-shaped, spreading, olive-green, 2'—3' long; sporangia oblong, spotted, with a narrow velum; ligula triangular; macrospores 0.40—0.47 mm. thick, covered with very minute, distinct or sometimes a little confluent warts; microspores papillose, 0.024—0.028 mm. long. Md.
- 7. I. riparia, Engelm. Leaves 15—30, slender, rather rigid, deep green, 4'—8' long, with numerous stomata; sporangia mostly oblong, distinctly brown-spotted, ¼ or ⅓ covered by the velum; macrospores 0.45—0.65 mm. thick, marked with isolated or anastomosing, jagged crests; microspores more or less tuberculated, 0.028—0.032 mm. long. Pa. and Del. to N. Eng. and northward. †† Velum complete.
- 8. I. melanospora, Engelm. Trunk flat, only slightly bilobed; leaves 5—10, distichous, slender, tapering, light green, $2'-2\frac{1}{2}$ long; sporangia orbicular or almost obcordate, $\frac{1}{2}$ long, entirely covered by the velum; macrospores 0.35—0.45 mm. long, roughened with distinct or rarely somewhat confluent warts, dark colored; microspores smoothish or slightly papillose, 0.028—0.031 mm. long. Ga.

** Peripheral bast-bundles present.
† Velum partial.

9. I. Engelmanni, A. Br. Leaves 25—100, light green, 9'—20' or more long, with abundant stomata; sporangia oblong—linear-oblong, unspotted, with a narrow velum; ligula elongate from a narrow base; macrospores 0.40—0.52 mm. thick, delicately honey-comb-reticulated; microspores generally smooth, 0.024—0.028 mm. long. Var. *Georgiana*, Engelm. has fewer leaves and larger (0.48—0.56 mm. thick) macrospores. N. Eng. and N. Y. to Ga.; also in Mo.

Var. gracilis, Engelm. Leaves 8—12, 9'—12' long, often submerged, the bast bundles often quite small or only two present. N. Eng. and N. J.

Var. valida, Engelm. Leaves 50—200, keeled on the upper side, 18'—25' long; sporangia 4''—9'' long, ½ to ½ covered by the broad velum; macrospores 0.32—0.48 mm. thick; microspores spinulose, 0.028—0.031 mm. long. Pa., Del.

10. I. Howellii, Engelm. Leaves 10–25, bright green, 5'-8' long, with thick dissepiments; sporangia oval, $1\frac{1}{2}''-2\frac{1}{2}''$ long, unspotted, $\frac{1}{4}$ to $\frac{1}{2}$ covered by the velum; ligula awl-shaped, as long as the sporangium; macrospores 0.43–0.48 mm. thick, rough with prominent, rounded, single or sometimes confluent tubercles. Ore.

†† Velum complete.

- 11. I. flaccida, Shuttleworth. Leaves 10—35, light green, 15′—2° long, submerged, floating on the surface or wholly emerged; sporangia oval, 2″—3″ long, entirely covered by the velum; macrospores 0.30—0.42 mm. thick, covered with many or rarely few, large flattish tubercles, distinct or confluent into labyrinthiform wrinkles. Var. *rigida*, Engelm. is smaller with more slender, erect, dark green leaves, 5′—6′ long. Fla.
- Var. Chapmani, Engelm. Leaves about 30, floating, 18' long; sporangia orbicular; macrospores 0.44—0.55 mm. thick, almost smooth on the upper side; microspores slightly papillose, 0.027—0.030 mm. long. Fla.
- § 3. Terrestrial; leaves nearly triangular with abundant stomata and peripheral bast-bundles, thick dissepiments and small aircavities.

* Velum partial or almost wanting.

12. I. melanopoda, J. Gay. Polygamous; trunk sub-globose, deeply bilobed; leaves 15—60, slender, stiff, erect, bright green, usually black at base, 5'—10' or more long; sporangia mostly oblong, 2''—5'' long, spotted, with a narrow velum; ligula triangular-awl-shaped; macrospores 0.25—0.40 mm. thick, with depressed tubercles often confluent into worm-like wrinkles, or

almost smooth; microspores spinulose, 0.023—0.028 mm. long. Var. pallida, Engelm. is larger with pale leaf-bases and broader velum. Ill., Ia., Ind. T., Tex.

13. I. Butleri, Engelm. Diœcious; trunk sub-globose; leaves 8—12, rigid, bright green, 3'—7' long; sporangia usually oblong, spotted, with a very narrow velum or none; ligula awl-shaped from a triangular base; macrospores 0.50—0.63 mm. thick, marked with knobs or warts, distinct or sometimes confluent; microspores papillose, dark brown, 0.028—0.038 mm. long. Var. immaculata, Engelm. is larger, with unspotted sporangia, and spinulose microspores. Ind. T. The var. in Tenn.

** Velum complete.

14. I. Nuttallii, A. Br. Trunk almost globose, slightly grooved; leaves 20—60, slender, bright green, 3'—9' long, with only three peripheral bast-bundles; sporangia oblong or oval, entirely covered by the velum; macrospores variable, 0.25—0.50 mm. thick, densely covered with minute but rounded warts, or rarely almost smooth; microspores papillose, brown, 0.025—0.028 mm. long. (*I. opaca*, Nutt.) Ore., W. T., Idaho.

SPECIAL NOTICE

The author of "Our Native Ferns and Their Allies" takes this occasion to announce that he is collecting materials for a Synopsis of the Hepaticæ in plan similar to the present work, and including classified descriptions of the North American species. He would be glad to receive any aid from those who use this volume who may be in any way interested in the Liverwort or Liver-mosses. Specimens especially those in fruit would be highly acceptable, particularly from the South and Far West.

Bloomington, Ill., May 1882.

GLOSSARY AND INDEX.

Derivations from the Latin unless otherwise stated. An asterisk (*) indicates an illustration at the page thus marked.

Α

Acrogen, (Gr. akron, the highest part, and gennan, to produce), a plant whose growth takes place at the summit. Includes Ferns, Mosses, etc.

Acrostichum, 80, also 14, 15, 24, 31*.

Aculeate, (aculeus, diminutive of acus, a needle), armed with prickles.

Adder-tongue. Vide Ophioglossum.

Adiantum, 86, also 14, 25.

Adnate, (ad to, nasci, to be born), growing fast to some other portion of the plant. Allosorus. Vide Cryptogramme.

Analogy, (Gr. ana, according to, logos, ratio, proportion), similarity in function distinguished from homology, indicating similarity in structure.

Anastomose, (Gr. anastomoun, to open into), forming a net-work; said of veins which unite with each other.

Aneimia, 112, also 30.

Annulus, (Lat. a ring), the ring partly or completely surrounding the sporangium.

Anophyte, (Gr. ano, upward, and phuton, a plant), a group of plants including the mosses and liverworts.

Antheridium, (plu. antheridia). (Lat. anthera, an anther, and Gr. eidos, form), the part containing the male element. 32.*

Antherozoid, (Lat. anthera, an anther, Gr. zoon, an animal, and eidos, form), the male element of cryptogams. 33.*

Archegonium, (plu. archegonia.) (Gr. archa, beginning, and gonos, seed), the part containing the female element. 32.*

Arcuate, (arcus, a bow), curved like a bow.

Arcola, (plu. arcolæ). (Lat. diminutive of arca, an open place), a space enclosed by anastomosing veinlets.

Asexual Generation, the growth produced from the fertilized oosphere. 34,

Asexual Reproduction in Ferns. 38.

Aspidium, 102, also 12, 14, 16, 21, 24, 28*, 38.

Asplenium, 97, also 12, 13, 14, 15, 27, 39.

Auriculate, (auricula, a little ear), furnished with ear-like appendages.

Azolla, 116.

В

Beech-fern. Vide Phegopteris.
Bi— (bis, twice), (as a prefix) two, twice or doubly.
Bibliography, 59—64.
Bladder-fern. Vide Cystopteris.
Blechnum, 96, also 27.

Botrychium, 71,* also 12, 13, 14, 31, 40, 41*.

Brake or Bracken. Vide Pteris.

Bulblets, 38.

C

Calamariaceæ, 43, 54. Camptosorus, 100, also 16, 28, 39*. Capillary, (capillus, a hair), hair-like.

Capsule, (capsula, a little box or case), a sporangium.

Carboniferous Age, number of American species of ferns, 19.

Carinate, (carina, a keel), keeled.

Castaneous, (castanea, a chestnut), chestnut-colored.

Caudate, (cauda, a tail), furnished with a slender appendage resembling a tail.

Caudex, (Lat. a stem), the upright rootstock forming the trunk of a tree-fern.

Cellulose, (cellula, a little cell), the substance composing the wall of cells, containing the elements, carbon, hydrogen, and oxygen.

Ceraceous, (cera, wax) having the nature of wax.

Ceratopteris, 95, also 15, 26.

Chartaceous, (charta, a leaf of paper), having the texture of paper or parchment.

Cheilanthes, 88, also 13, 15, 26, 38.

Chlorophyll, (Gr. chloros, green, and phullon, leaf), the green grains forming the coloring matter of plants.

Christmas-fern. Vide Aspidium.

Ciliate, (cilium, an eye-lash), having on the margin a fringe of hairs resembling the fringing eyelashes.

Cinnamon-fern. Vide Osmunda.

Circinate, (circinus, a pair of compasses), rolled inward from the apex.

Classification of Pteridophyta, 54; of the Vegetable Kingdom, 52-54; Principle of, 52.

Cliff-brake. Vide Pellæa.

Climbing-fern. Vide Lygodium.

Cloak-fern. Vide Notholæna.

Club-moss. Vide Lycopodium.

Confluent, (con. together, and fluere, to flow), blended together.

Connate, (con, together, and nasci, to be born) united together from the first. Cordate, (cor, the heart), heart-shaped.

Coriaceous, (corium, a hide), leathery,

Cotton-fern. Vide Notholæna.

Crenate, (crena, a notch) having the margin scalloped with rounded teeth.

Crenulate, (crenula, a little notch), scalloped with small rounded teeth.

Cryptogamia, (Gr. kruptos, hidden, gamos, marriage), flowerless plants.

Cryptogramme, 92, also 26, 31*.

Cuneate, (cuneus, a wedge), wedge-shaped.

Cystopteris, 108, also 15, 29, 31*, 39.

D

Decurrent, (de, down, and currere, to run), prolonged on the rachis.

Deer-fern. Vide Lomaria.

Deltoid, (Gr. delta, the letter D, and eidos, form), triangular like the Greek delta,

Dentate, (dens, a tooth), toothed.

Denticulate, (denticulus, diminutive of dens, tooth), finely toothed.

Devonian Age. Number of American species of ferns, 19.

Dichotomous, (Gr., dicha, asunder, and temnein, to cut), two-forked.

Dicksonia, 110, also 13, 14, 16, 29.

Dimorphism, 12.

Dimorphous, (Gr. dis, twice, and morphe, shape, form), of two forms; said of ferns whose fertile fronds are unlike the sterile.

Dioccious, (Gr. dis, twice, and oikia, house), bearing the male and female organs on different plants.

Distichous, (Gr. dis, twice, and stichos, a row), disposed in two rows. Dorsal, (dorsum, the back), pertaining to or situated on the back.

E

Ebeneous, (ebenus, ebony), black like ebony.

Elater, the spirally coiled appendages of the spores of Equisetum.

Endospore, (Gr. endon, within, and sporos, a seed), the inner wall of the spore.

Epidermis, (Gr. epi, upon, and derma, the skin), the external covering of the plant. Epiphytic, (Gr. epi, upon, and phuton, a plant), growing upon another plant, but not nourished by it.

Equisetaceæ, 42, 52, 67.

Equisetum, 67, also 42*,

Exospore, (Gr. exo, outside, and sporos, a seed), the external covering of the spore.

F

Falcate, (falx, a sickle), scythe-shaped; slightly curved upward.

Farinose, (farina, ground corn), covered with a white or yellowish powder.

Ferruginous, (ferrum, iron), resembling iron rust.

Fertilization, 32.

Fibrillose, (fibra, a thread), formed of small fibres.

Filices, general characters, 11, 74.

Filiform, (filum, a thread, forma, form), thread-like.

Flabellate, (flabellum, a fan), fan-shaped; broad and rounded at the summit and narrow at the base.

Flaccid, (flaccus, flabby), soft and weak.

Floating-fern. Vide Ceratopteris.

Flowering-fern. Vide Osmunda.

Foliaceous, (folium, a leaf), having the nature of a leaf.

Fovea, (Lat. a small pit), the depression in the leaf of *Isoetes* containing the sporangium.

Frond, (frons, a leafy bough), that which answers to the leaf in ferns, 21, 37.

Fructification of Ferns, 23; of OPHIOGLOSSACEE, 41; of Equisetum, 43; of Clubmosses, 44; of Isoetes, 46; of Marsilia, 48.

Fulvous, (fulvus, reddish-yellow), tawny.

G

Genera, 51.

Generic Names, 49.

Geographic Distribution of Ferns, 16.

Geologic Distribution of Ferns, 18; of Equisetum, 43; of Club-mosses, 46; of Isoetes, 47; of Marsilia, 48.

Germination of Ferns, 32; of Ophioglossacez, 41; of Equisetum, 43; of Clubmosses, 45; of Isoeles, 47; of Marsilia, 48.

Glabrous, (glaber, smooth), smooth.

Glanduliferous, (glandula, a little kernel, and ferre, to bear), furnished with glands.

Glaucous, (Gr. glaukos, sea-green), covered with a bloom like a plum.

Globose, spherical in form or nearly so.

Gold-fern. Viide Gymnogramme.

Grape-fern. Vide Botrychium.

Ground-pine, Ground-fir, etc. Vide Lycopodium.

Gymnogramme, 82, also 13, 21, 25, 31*.

н

Hartford-fern. Vide Lygodium. Hart's-tongue. Vide Scolopendrium.

Hastate, (hasta, a spear), furnished with spreading lobes on each side at the base.

Herbaceous, (herba, an herb), having the texture of common herbage.

Heterosporous, (Gr. heteros, other, and sporos, a seed), producing two kinds of spores as in Selaginella, etc.

Histology, (Gr. histos, web, tissue, and logos, a discourse), the study of the microscopic characters of the tissues of plants and animals, 58.

Holly-fern. Vide Aspidium.

Horsetail. Vide Equisetum.

Hymenophyllaceæ, 24, 37, 77.

Ι

Imbricated, (imbrex, a hollow tile), breaking joints like slates or shingles.

Indusium, (plu. indusia,) (induere, to clothe), the membranous covering of the sporangia in many species of ferns, 24.

Inferior, attached below; said of an indusum below the sporangia as in Woodsia.

Intramarginal, (intra, within, and margo, a border), near the margin.

Involucre, (involvere, to wrap up), the indusium.

Isoetaceæ, 46, 54, 121.

Isoetes, 121, alse 46, 47*.

Isosporous, (Gr. 1808, equal, and sporos, a seed), producing spores of one kind.

L

Lace-fern. Vide Cheilanthes.

Lacinia, (plu. laciniæ) (Lat. the lappet of a garment), a long narrow lobe.

Lady-fern. Vide Asplenium.

Lanceolate, (lanceola, a little spear), lance-shaped.

Lepidodendraceæ, 46, 54.

Ligula, (Lat. a strap), a triangular or somewhat elongated stipule-like organ of the leaf in *Isoetes*, situated above the sporangia.

Linear, (linea, a line), long and narrow.

Lip-fern. Vide Cheilanthes.

Lobule, (lobulus, diminutive of lobus, a lobe), a small lobe.

Lomaria, 95, also 27*.

Lunate, (lung, the moon), crescent-shaped.

Lunulate, (lunula, diminutive of luna, the moon), smaller than lunate.

Lycopodiaceæ, 44, 52, 54, 116.

Lycopodium, 117, also 44*, 45*.

Lygodium, 112, also 13, 30, 31*,

M

Macro- (Gr. makros, long), (as a prefix) large or long,

Maidenhair. Vide Adiantum.

Male-fern. Vide Aspidium.

Marattiaceæ, 52, 54.

Marsilia, 114, also 48*.

Marsiliaceæ, 48, 52, 54, 114.

Micro - (Gr. mikros, small), (as a prefix) small.

Midvein, the middle or main vein of a frond, pinna, pinnule, or segment.

Monœcious, (Gr. monos, single, and oikia, house), bearing the male and female organs on different parts of the same plant.

Moonwort. Vide Botrychium.

Mucronate, (mucro, a sharp point). having the midvein prolonged beyond the pin-nule, forming a sharp point

N

Nephrodium. Vide Aspidium.

Nephrolepis, 108, also 16, 29.

Nomenclature, 49,

Notholaena, 83, also 15, 21, 25, 31*, 38.

0

Oak-fern. Vide Phegopteris.

Oblong, from two to four times as long as broad.

Obovate, (ob, reversed, and ovum, an egg), inverted ovate.

Onoclea, 109, also 12, 13, 14, 20, 22, 29.

Oosphere, (Gr. oon, an egg), the female element of Cryptogams.

Oospore, (Gr. oon, an egg, and syoros, a seed), the fertilized oosphere.

Ophioglossaceæ, 39, 52, 54, 70.

Ophioglossum, 70, also 16, 40*.

Orbicular, (orbiculus, diminutive of orbis, a circle), circular.

Orders, 51.

Osmunda, 113, also 13, 14, 15, 24*, 30, 31.

Osmundaceae, 24, 77.

Ostrich-fern. Vide Onoclea.

Ovate, (oxum, an egg), having the form of the longitudinal plane of an egg with the base downward.

Ovoid, (ovum, an egg, and Gr. eidos, form), having the form of an egg.

P .

Paleaceous, (palea, chaff), clothed with chaffy hairs.

Palmate, (palma, the hand), with the divisions spreading from the end of the stalk like the fingers of the hand.

Panicle, (panicula, a tuft on plants), an open cluster, consisting of more or less branching stems bearing fruit.

Papillose, (papilla, a nipple), bearing minute, nipple-like projections.

Papyraceous, (papyrus, paper reed), having the texture of paper.

Pedicel, (pediculus, diminutive of pes, foot), the stalk of a sporangium.

Pellaea, 92, also 13, 15, 26.

Peltate, (pelta, a small shield), shield-shape; said of an indusium borne on a stalk attached at its centre.

Pentagonal, (Gr. penta, five, and gonia, angle), having five sides.

Pepperwort. Vide Marsilia.

Petiole, (petiolus, diminutive of pes, foot), the stalk of a pinna or pinnule.

Phegopteris, 101, also 14, 22, 28.

Pilose, (pilus, hairy), covered with soft hairs,

Pilularia, 115, also 48.

Pinna, (Lat. a feather), the primary division of a compound frond.

Pinnate, (pinna, a feather), having the divisions of the frond arranged on the two sides of a common rachis.

Pinnatifid, (piuna, a feather, and findere, to cleave), having the sides of the frond, pinna, or pinnule, cut half-way or more to the midvein.

Pinnule, (pinnula, diminutive of pinna, a feather), the secondary division of a frond twice or more compound.

Polypodiaceae, 23, 74.

Polypodium, 80, also 16, 22, 23*, 24, 31*.

Pro-embryo, the thread-like prolongation between the germinating spore and the prothallium.

Prothallium, (Gr. pro, previous to, and thallos, a young shoot), the sexual generation of a fern, 32*,

Psilotum, 119, also 44, 45.

Pteridoid, (Gr. pteris, fern, and eidos, form), fern-like in appearance.

Pteridophyta, (Gr. pteris, fern, and phuton, plant), characters of, 67; classification of, 54.

Pteris, 87, also 15, 26*.

Q

Quadri- (quattuor, four), (as a prefix) four, fourfold.

R

Rachis, (Gr. the spine), the continuation of the stipe through a compound frond.

Raphe, (Gr. a seam or suture), the ridge which connects the sporocarp with its stem in Marsilia.

Rattlesnake-fern. Vide Botrychium.

Receptacle, (recipere, to receive), the part to which the sporangia are attached especially in the HYMENOPHYLLACE.

Reniform, (renes, the kidneys), kidney-shaped.

Resurrection-plant. Vide Selaginella.

Revolute, (revolvere, to roll back), rolled backward; said of the margin of fronds.

Rhomboidal, (Gr. rhombos, a rhomb, and eidos, form), approaching a rhomb in shape.

Rock-brake. Vide Cryptogramme.

Rock-moss. Vide Selaginella.

Roots, 37.

Rootstock, an underground stem, 21.

S

Salviniaceæ, 52, 54, 116.

Scandent, (Scandere, to climb), climbing.

Schizæa, 113, also 24*, 30*, 31*.

Schizæaceæ, 24, 77.

Scolopendrium, 100, also 12, 15, 28*, 31, 38.

Scouring-rush. V.de Equisetum.

Segment, one of the divisions of a pinnatifid frond.

Selaginella, 120, also 44, 45*.

Selaginellaceæ, 44, 120

Sensitivc-fern. Vide Onoclea.

Serrate, (serra, a saw), having the margin cut into teeth pointing forward.

Sessile, (sedere, to sit), without a stalk or petiole.

Setiform, (seta, a bristle, and forma, form), bristle-like.

Sexual Generation, the growth of the prothallium from the spore producing the sexual organs, archegonia and antheridia, 32*.

Shield-fern. Vide Aspidium.

Sigillariaceæ, 46, 54.

Sinuate, (sinus, a bending), having the margin alternately bending inward and outward.

Sinus, (Lat. a bending), a recess or bay; the re-entering space between two lobes.

Sorus, (plu. sori) (Gr. soros, a heap or cluster), the clusters of fruit in the Poly-PODIACEÆ.

Spatulate, (spatula, a little spoon), shaped like a spatula.

Species, 50. How to determine, 55.

Specific Names, 49.

Spinulose, (spina, a thorn), thorny.

Spleenwort. Vide Asplenium.

Spore, (Gr. sporos, a seed), the fruit of the higher cryptogams, produced asexually, 30.

Sporangium, (plu. sporangia) (Gr. sporos. a seed, and aggeion, a vessel), the case or capsule euclosing the spores.

Sporocarp, (Gr. sporos, seed, and karpos, fruit), the fruit-bearing receptacle in Marsilia, etc.

Squamous, (squama, a scale), with appressed scales.

Stellate, (stella, a star), star-shaped.

Stipe, (stipes, a stock), the stem of a frond, 37.

Stoma, (plu. stomata) (Gr. a mouth), the breathing pores of plants, 38, 43.

Stramineous, (stramen, straw), straw-colored,

Struthiopteris, Vide Onoclea.

Sub- (as a prefix), about, nearly, somewhat.

Sub-Orders, 51.

Subulate, (subula, a shoemaker's awl), awl-shaped.

Superior, higher, applied to indusia that are attached above the sorus as in As-pidlum.

Synonymy, 50.

Т

Tænitis, 85, also 16, 25.

Ternate, (terni, three each), branching into three nearly equal divisions.

Thallogen, (Gr. thallos, a young shoot, and gennan, to produce), a group of cryptogams including the lichens, fungi, etc.

Thalloid, (Gr. thallos, a young shoot, and eidos, form), having the form of a thallogen.

Tissues, 36.

Tomentose, (tomentum, a stuffing of wool), covered with matted woolly hairs.

Tomentum, (Lat. a stuffing of wool), the dense matted woolly hair found on some ferns as many species of Cheilanthes,

Tri- (tris, three), (as a prefix) three, thrice.

Tribes, 51.

Trichomanes, 110, also 15, 24*, 30*.

Trichomes, (Gr. trichoma, a growth of hair), hairs, variously modified as scales, indusia, sporangia, etc., produced from the epidermal cells.

Triquetrous, (Lat. triquetrus), three-angled.

Truncate, (truncare, to cut short), cut off abruptly.

Tufted, growing in clusters.

U

Undulate, (undula, a little wave), wavy-margined.

V

Vallecula, (plu. valleculæ), the grooves on the stems of Equisetum.

Variation among species, 12.

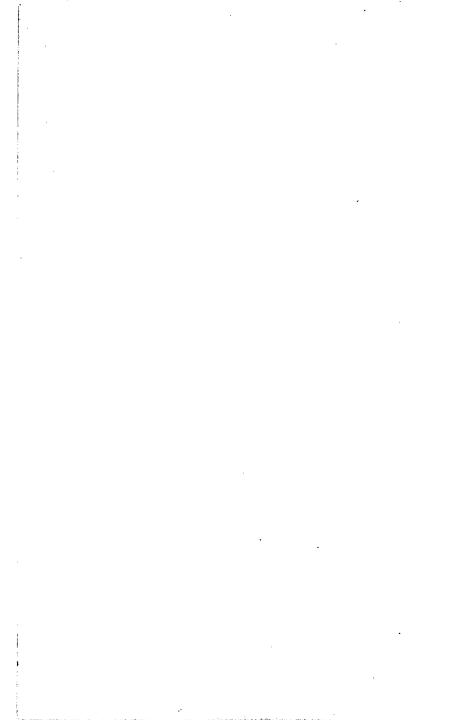
Varieties, 51.

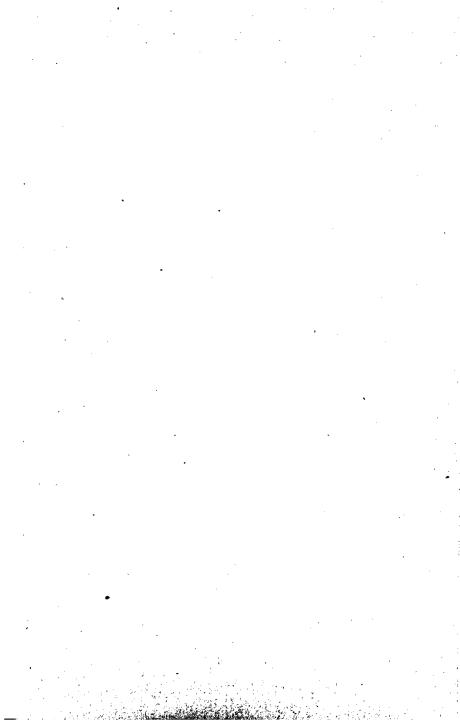
Vascular, (vasculum, diminutive of vas, a vessel), containing vessels as ducts, etc. Velum, (Lat. a curtain), the membranous margin of the fovea in Isoetes. Venation, (vena, a vein), the veining of the frond, 22. Vernation, (ver, spring), the arrangement of the leaves or fronds in the bud. Vittaria, 86, also 16, 25.

W

Walking-leaf. Vide Camptosorus. Water-fern. Vide Marsilia. Wood-fern. Vide Aspidium. Woodsia, 109, also 15, 24, 29*. Woodwardia, 96, also 14, 22, 27.

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